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THE MAGAZINE OF SCIENTIFIC PROGRESS

JUNE 1960

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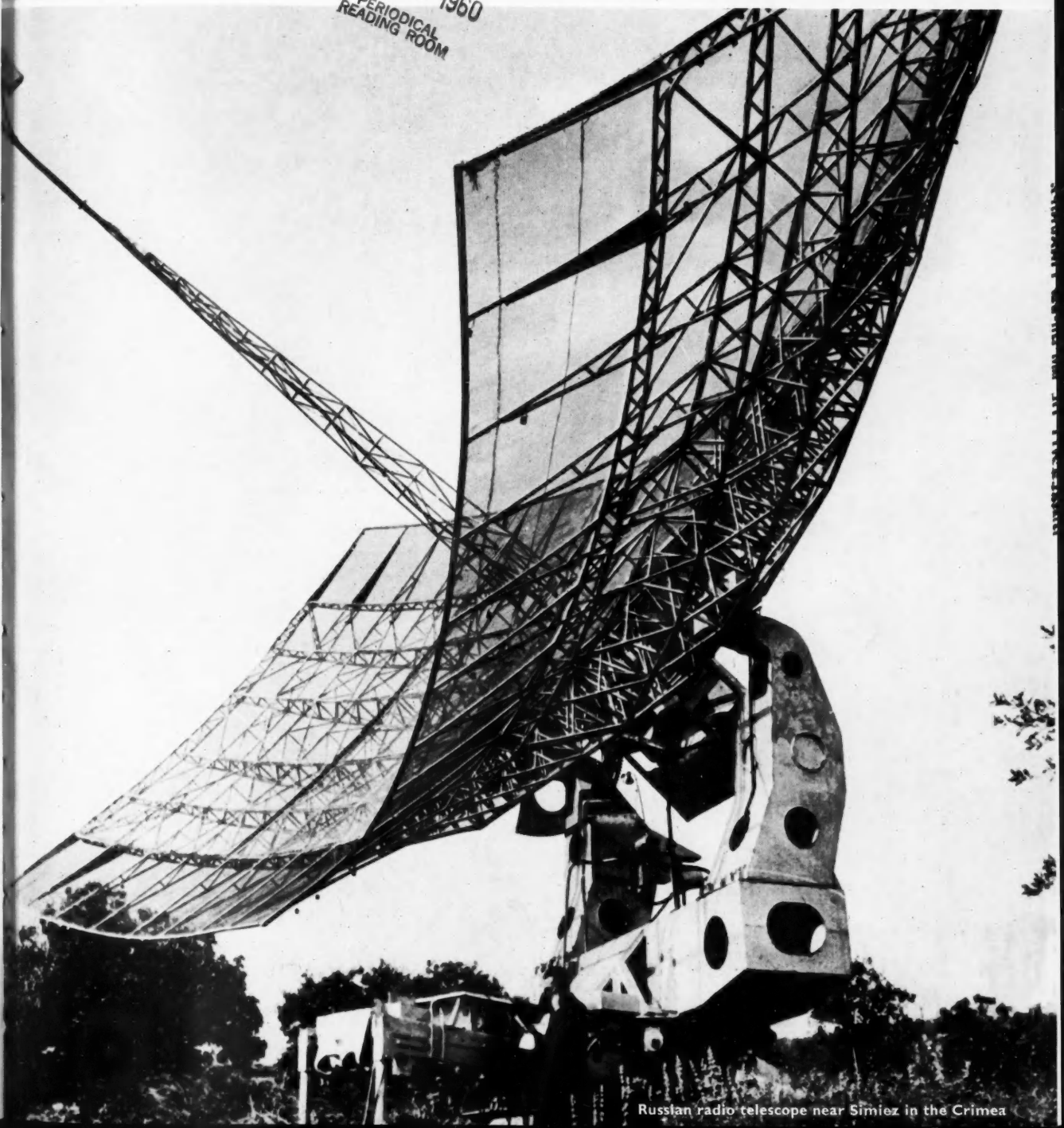

Russian radio telescope near Simiez in the Crimea

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OUR COVER PICTURE

The radio telescope at the Crimean Station of the Physics Institute of the U.S.S.R. Academy of Sciences, has 18-m. antennae and is used for the study of radio waves coming from interstellar hydrogen. It is part of the thorough Russian preparation for interplanetary flights, and it is no doubt being used at present to follow the 4½-ton Russian space-ship.

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THE PROGRESS OF SCIENCE

PAY AND THE SCIENTIST

The remuneration of scientists is becoming a matter of topical concern. On March 1, 850 professional, scientific, and technical employees at Harwell applied for a day's leave as a gesture of dissatisfaction with their pay-structure. Was this a modest portent of a national strike by "boffins" which could paralyse a nation? The Royal Commission on "doctors' pay", while recommending fairer treatment for the medical profession, also provided significant evidence that certain scientific occupations, too, were underpaid. Again, the Fifth Report of the Overseas Migration Board has failed to relieve our anxiety about the drain overseas of part of the nation's scientific manpower. Yet overshadowing all is a more vital question: what role will the pay of scientists play both in the nation's scientific manpower objectives and in the debate about the scale of our country's scientific effort?

On this question, DISCOVERY has always been militantly "pro-science". However, we do not regard the slogans "more science" and "more scientific manpower" as facile cure-alls. We concede that there are risks of "intellectual unemployment" if the universities are over-expanded; that increased scientific manpower and increased productivity need not be causally interlinked; that there is a *reductio ad absurdum* if the growth of the nation's scientific manpower were to continue indefinitely; that the nature of the deployment of our scientific effort is as important as its quantum. We must, however, ask ourselves two questions which spotlight the pay-issue: whether the supply of scientists is adequate to meet current demand, and more broadly whether our scientific effort is adequate for modern needs. Here, too, it would be an oversimplification to suggest that pay is the sole or even the main determinant of job-recruitment. Nevertheless the question is: in an economy where the distribution of resources is powerfully influenced by the market, do the rewards, not least the rewards of scientists, adequately conform with the rules of that market?

As to the balance of supply and demand for scientists, the Advisory Council for Scientific Policy would appear to be relatively satisfied with the current position and future trends. While there are imperfections—too many biology graduates and too few graduates in mathematics, physics, and chemistry to man up the teaching profession, the general manpower position is in equilibrium. Nevertheless, many observers would echo the sentiments of that responsible authority, Prof. Jewkes, who has commented: "My impression is that the earnings of scientists are still not outstanding in the professional hierarchy".* It is even doubtful whether, despite all the emphasis given to scientific manpower in recent years, scientific salaries have risen significantly more rapidly than other salaries. The remuneration of engineers, to take a critical area, £59,000 over a working life, compares most unfavourably with many other professions, let alone commerce and trade, and while some branches of science, for example, chemists, appear to be better remunerated, there is the suspicion that among those in the highest groups are some who have gone over to the management side of industry.

* "How Much Science?" *Economic Journal*, March 1960.

It would be wrong to view the problem only in the light of narrow market criteria. We do not dissent from the findings of the Royal Commission on "doctors' pay" that "Earnings ought not to be determined by short-term supply and demand. The level of demand is artificial and is easily increased or reduced by Government action, whereas the supply of skilled people cannot be quickly adjusted". We have to distinguish between the nation's real requirements in the field of pure science which we may be near meeting, and its requirements in the application of science, that is, our potential in technology, where because *inter alia* of underpayment, and hence our real lack of engineers, we are lagging behind. It is idle to pretend that if we are to witness some modest operation of the iron laws of supply and demand in the scientific arena, this will not have consequences both in the universities and in the teaching professions. Can we have more scientists merely by increasing the university population, and without some shrinkage in the arts faculties? Then again, should supply and demand be allowed to operate in favour of scientists in the university teachers' salary structure? Even more critical is the problem of teachers' pay. The Government recognise that there is still an acute shortage of science teachers and numerous steps have been taken to alleviate it. Yet we would highlight Prof. Carter's and Prof. William's viewpoint in their work "Science in Industry" that "we have heard no convincing suggestions for alleviating the shortage other than by paying science and mathematics teachers more". More self-defeating and costly is their advocacy of raising the pay of all graduate-teachers if it were necessary for achieving this objective. For, indeed, science has suffered overlong from an absence of favourable differentials.

A classic case of course was in 1954, when the Government and the FBI appealed to employers not to overbid for scientists and thus prevent their going into teaching. That policy carried to its logical conclusion is a counsel of despair. For the Government, as the main science employer in fact, sets the level of remuneration not merely for scientists within the Civil Service, but also for outside. The effects of this cannot be overlooked. It means that given the subordination of scientists to administrators in the Civil Service, there are institutionalised pressures to keep the scientist "on tap and not on top" throughout the economy. Finally, if it is felt that this diagnosis is exaggerated, we draw attention to the emigration figures, where evidence of significant migration of engineers and teachers is available —a trend which seems to be increasing rather than decreasing.

A brief editorial cannot prove that scientists are underpaid. We could have quoted many more examples. Rather, our objective has been to focus attention on this subject. To plead for a more thorough and systematic collection of data on scientific salaries, promotion prospects, and fringe benefits, and to hope that those who seek to plan the future of Britain's scientific manpower will realise that the price-mechanism through the remuneration of scientists is indeed a fit tool for planners.

POWER FROM THE WINDS

A new windmill developed after ten years of research by the Ministry of Power and several more years of work by R. Smith (Horley) Ltd promises to be both serviceable and soundly economic. In its initial tests in the Isle of Man it has been running without the usual teething troubles and has produced electricity fully up to expectations.

The rise of the modern windmill has of course hinged on its association with electricity, which dates from the turn of the century, and on the disappearance of cheap and abundant coal. Many countries became interested in aero-generators, particularly France, Holland, and Denmark. Advantage was taken of aircraft techniques, and between the two wars some highly ingenious new types of windmill were invented.

In France, Darrieus used the principle of stall to regulate his machine to run at nearly constant rotational speed by increasing the inclination of the air-stream to the blades as the wind rose, and in 1931 Russia built a 100-kW mill mounted on a 100-ft. tower which had metal covered blades turning on an axis parallel to their length so that in high winds the inclination of the blade to the wind could be reduced. This pitch-changing, which is used on aircraft propellers, was brought about by centrifugal force on offset ailerons. But control was difficult and the installation was too expensive.

The next development was in America. In 1941 the S. Morgan Smith Company erected a two-bladed 1250-kW mill, the largest so far built. Some of its special features were pitch-changing, a hydraulic slipping coupling for driving the generator, and a hinge at the root of the blades which allowed them to lean away from the wind under a combination of wind thrust and centrifugal force, a device known as "coning". This mill came to grief in a high wind, but Putnam's published a detailed account of the project which has served as a guide-book for inventors ever since.

The severe fuel shortage after the Second World War gave a fresh impetus to millwrights, and intensive studies of the subject were made in Great Britain, France, Germany, Denmark, and other countries. In Great Britain a machine built by John Brown and Company was set up in the Orkneys in 1950. Its three blades were given greater freedom of movement by a universal joint, in place of the coning hinge, and there was a complex system of springing to cushion the bedplate which carried the blades, main shaft, and generator.

Dowsett Holdings built several models, making use of variable-pitch rotors, a solenoid valve to open the circuit on a failure of the mains, an airspeed control trip, and an excess wind paddle which opened the circuit in winds of over 60 m.p.h. A still more novel type of windmill was designed by Enfield Cables which embodied a pneumatic transmission system invented by Andreau in France. In this machine, which is now running satisfactorily in Algeria, the blades are hollow with a hole at the tip, so that in rotating they suck in air which is ducted to the base of the tower to operate a turbine.

The trouble with these and other types of windmill erected on the Continent was that they were too complicated and not really economic. It had been hoped to build bigger mills at a comparatively low cost which would work reliably and generate current at a figure at least as low as in a modern power station, but judging from the performance of these experimental models the outlook did not appear very promising.

The Electrical Research Association which carried out a detailed survey of the winds on the west coast thought that sites could be found which were windy enough to produce 4000 kWh of energy per annum for each kilowatt of capacity installed and that suitable plant might be built for about £50 per kilowatt. Taking capital charges at 8%, this would mean a generation cost of a farthing per kilowatt-hour, which compares favourably with the generating cost in steam power stations. But it remained to translate these theoretical calculations into practice.

A great deal of valuable experience was gleaned from the Brown, Dowsett, and Enfield machines, and several important points emerged. It became clear that a "conventional" design, with the generator mounted on the top of the tower and driven by some form of gearing, was the most promising arrangement; that the rotor should have three blades and should be held up-wind of the tower by a fantail; and that there was little advantage in high towers. The chief difficulties still remained vibrations in the whole structure, which might disintegrate the mill, oscillations in the power output, and the need for really good controls to start the mill when the wind was high enough and to stop it in an emergency.

The new Smith windmill seems to meet all these points. A 100-kW model weighing only 6½ tons, it can easily be parcelled for export. This lightness and handiness is due to its simplicity of construction and the novel use of extruded aluminium for its three 25-ft. blades. Also its tubular steel tower is only 35 ft. in height, which is just enough to give the blades sufficient clearance from the ground.

A fantail keeps the rotors into the wind, and the controls are not at all complex. There are no hydraulics, no coning and no electric devices. A disc brake which is brought into action by centrifugal force regulates the speed of rotation, and as an emergency measure there are air-flaps at the ends of the blades which when the speed exceeds 750 r.p.m. shear a pin and drop off.

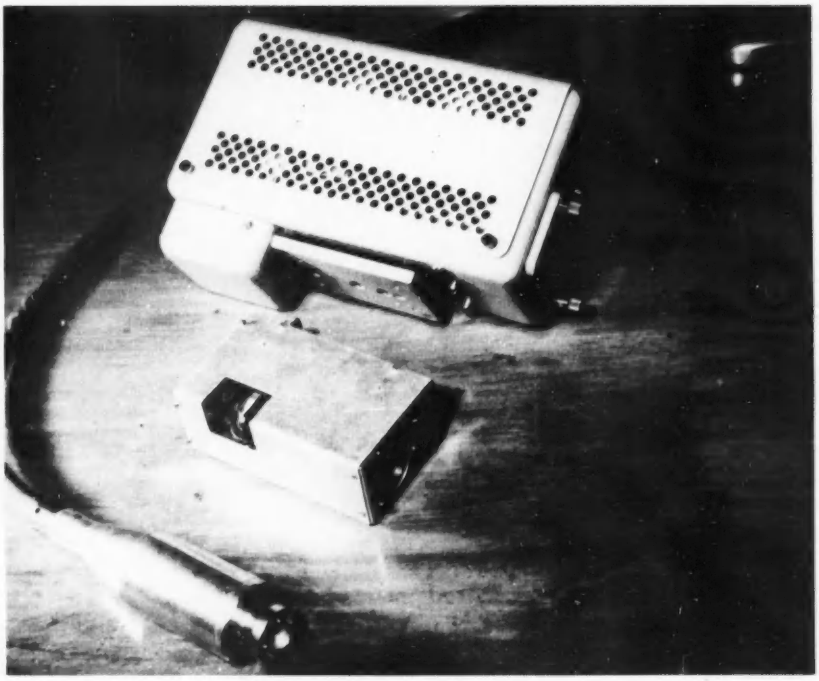
This is said to be the cheapest modern windmill ever made, but its construction is robust. Tie-rods connect the mid-points of the blades in the plane of rotation and also to a forward extension of the main shaft; and at each fastening they are secured by no less than twelve bolts. It is believed that the mill will have a life of at least ten years and that it should write off its cost in five years.

It works well in winds of 25 m.p.h., and is economic if winds blow for one-third of the year. In tests, 100 units of electricity have been generated in an hour; the aim is 250,000 units per annum. The cost of generation works out at about a farthing a unit. This compares favourably with Denmark's newest mill at Gedser which generates current at about 4d. a unit.

The Smith machine may possibly be the beginning of a new chapter in the windmill's history. Modern mills can be used as adjuncts to water-turbine plants and to supply power in desert regions and to large outlying farms. For

The first of the new Smith windmills, producing 100 kW with three 25-ft. blades at a height of 35 ft. above ground.

coast-guard stations and lighthouses they can feed energy into floating batteries, and in regions such as the outback of Australia windmills can pump water from bore-holes and provide current for the purification of salt water by electrodialysis. And, of course, they can supplement the power stations. It is thought that about 2 million kW of wind-driven plant could be installed in Great Britain with an annual saving of 2 or 3 million tons of coal.



Dr Berci's new camera, foreground, is dwarfed by a 16-oz. camera earlier developed by the team, and the larger industrial vidicon camera which was used in their first experiments.

TELEVISION ENDOSCOPY

To be able to look into the living body and to observe the appearance, movement, and behaviour of living organs has for long been a fascinating problem of medical science. In 1854, Manoel Garcia, Professor of Singing in Paris and London, was the first to observe the movements of the vocal chords with the aid of a mirror. From this early laryngoscope a veritable galaxy of endoscopes have been designed. Some, as for instance for viewing into the bronchi, are open tubes with a fairly wide diameter. Others, such as the cystoscope for observation inside the bladder, contain a complex system of lenses. In all but the widest endoscopes, adequate lighting presents a major problem. Most scopes employ a tiny low-voltage electric bulb at the distal end. A recent French system makes use of a bundle of quartz rods which conducts the light from a proximal light-source to the distal end inside the body. In some countries, notably in Germany, surgeons inspect the liver and associated structures by inserting an endoscope through a tiny incision in the abdominal wall. There are thus no orifices, from the ear to the urethra, and very few organs which have not been explored with one endoscope or another.

However, to see for oneself is one thing, to communicate endoscopic appearances and phenomena to students is quite another problem. Many brave attempts were made to obtain adequate black-and-white photographs. The advent of colour photography has encouraged a number of workers to try temporarily overrun tungsten filament bulbs, flash bulbs, and even electronic flash-discharge tubes[1] in an effort to engender sufficient light within the body to record a really sharp picture, without any blurring due to movement, and in true colour. Holinger and Brubaker,[2] in America, and Fourestier, Gladu, and Vulmière,[3] in France, have brought colour still and cine endoscopy to a remarkable state of perfection, so that it is now possible to observe and to record appearances inside the human body.

Nevertheless, few medical teachers will be satisfied with this achievement. Whilst still photographs and motion-picture films can be projected to large audiences, it is *post hoc* illustration and loses much in reality and spontaneity. Television is therefore the next logical step. It promises to let not just one but many students see, greatly enlarged, exactly what the surgeon sees through his endoscope. Lighting of the area under examination presents no additional difficulty, as the television camera tube itself is remarkably sensitive and its signals can be amplified before they are translated into a visual image on the screen. The real problem is inherent in the weight and bulk of conventional television cameras. No endoscopic examination should be a danger to the patient or cause additional discomfort. It must therefore be possible to attach the camera to the endoscope in such a way that it does not in any way threaten to impale the patient on the endoscope. Beyond this it is essential that the surgeon should view directly and continuously through the endoscope and direct it with a smooth and delicate touch. This implies that the camera should have no weight of its own. Cardew, at St Mary's Hospital Medical School has achieved this with his motion-picture camera through a well-counterpoised system of suspension. Trethowan,[4] at Guy's Hospital, solved the problem of mirror laryngoscopic photography by attaching a reflex mirror camera to a head frame, so that the camera will at all times record what the examining surgeon can see. Moore and von Leden,[5] in New York, have adapted this idea by mounting a small industrial vidicon television camera horizontally on top of a light-weight helmet. A

periscope ensures that the televised field coincides with visual observation. However, both counterpoised-suspension and head-supported systems are but ingenious devices to overcome problems of bulk and weight only suitable for direct or open-tube endoscopy. Really deep insertion into smaller and therefore more delicate structures demands that endoscope and recording instrument should form one unit which can be controlled by the surgeon without additional effort of manipulation.

Berci, at the University of Melbourne, who came from Hungary in 1956, has gathered around him a small team of engineers who have helped him to devise a television instrument which fulfils the specifications of diminutive size and lightness. He first constructed a television camera which weighs only 16 oz. and measures 2×3×5 in., and has since replaced this with another about half the size.

This structure contains a German miniature vidicon tube, a miniaturised deflection coil, and part only of the pre-amplifier. The front of the instrument can be attached to an endoscope equipped with a viewing eyepiece, while the other end is connected through a cable to the other part of the pre-amplifier and the remainder of the control equipment. A very small vidicon tube, as well as miniature resistors and transistors, have contributed to the diminutive size of this camera. However, the real value of this improvement lies in the separation of the pre-amplifier into two parts which are connected by a flexible cable. Berci and his colleagues hope that this approach may eventually enable them to pass the light-sensitive part of a television camera right inside the body, instead of merely attaching it to the proximal end of an endoscope, as first suggested by Wallman and Rosengren in 1956.[6] This may prove a valuable and most interesting revolution in present-day methods of endoscopy.

Since Potts *et al.*,[7] at the National Institute for Health in the United States of America, were able to use colour television to demonstrate and record the flow of blood through the vessels of the human retina, it may not be totally unrealistic to hope that Berci will one day show us the internal living anatomy not only in black and white but in its actual colours.

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A GREAT OPPORTUNITY—SPACE

Paradoxically, the placing in jeopardy of Britain's independent deterrent through the cancellation of the *Blue Streak* rocket as a defence project has improved the chances of Britain's having an independent space programme. This is hardly the way one would have wished this policy to come about; nevertheless such an outcome is much to be welcomed. By the time this issue appears we shall probably know one way or the other. Let us hope the Government will have taken the courageous, the foresighted, course of faith, and not merely played safe. There are some occasions where parsimony is more wasteful than extravagance. This, in our sincere opinion, is one of them.

There are reasons for thinking that the compromise British space project based on American facilities adopted last summer is not ideal. No reproach or criticism of the open-handed generosity of our American allies and collaborators is in any way implied in saying this. Sir Edward Bullard, F.R.S., Chairman of the Royal Society Space Research Steering Committee, aptly characterised the present arrangement as "getting our feet wet cheaply". It is just that. But is this the way to go into one of the greatest adventures imaginable? Is this the kind of attitude that produces that white-hot fusion of imagination and intellect which surely underlies really worth-while and fruitful scientific research?

The scale and manner of the present programme as it is developing is not providing sufficient stimulus to British industry to be of any real value. No doubt the industries concerned are themselves considerably to blame, but then this suggests that they need more stimulus rather than less. Moreover the present collaborative arrangement does impose inhibitions on British experimenters, and therefore restricts their freedom of choice. There are experimental areas (such as measurements of the Van Allen belts) where it is felt by British scientists that they would be trespassing on American preserves. This is not a healthy feature in a basic research situation.

This matter of space research is likely to prove a test case of the British leaders' capacity for leadership in matters scientific, and on this survival itself depends. Despite plentiful writing on the wall there is no sign yet that governments with a maximum lifetime of five years can bring themselves to risk present unpopularity for the sake of ultimate well-founded economic well-being. This of course means, in terms of our peculiar British situations tightening our belts and spending large sums of money on basic research in frontier science *now*, for the sake of an advanced position and therefore exports in goods and tools and "know-how" later. The demand is assured but the competition is fierce and getting fiercer.

Space research is a frontier science making critical use of other frontier sciences (such as advanced metallurgical and electronic skills). It is upon the achievements of the frontier sciences that advanced technology builds. And unless we maintain our position among the leaders of advanced technology and thus the supplier of goods to a large proportion of the rest of the world we shall not survive. It is not merely a matter of maintaining the nation in the style to which it has been accustomed, survival itself is involved. The purest science is also the purest self interest.

PHIL. TRANS.—THE FIRST FIFTY YEARS

LEONARD G. HULLS

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The early editions of Phil. Trans., *the journal of the Royal Society, appearing at a time when learned people still believed in witches, record the careful work of experimental scientists such as Newton, Boyle, Hooke, and Halley.*

The abbreviation *Phil. Trans.* is well known to all men of science. It signifies the *Philosophical Transactions of the Royal Society*, a journal wherein the highly erudite are able to publish the results of their researches. One wonders how many people are aware of the fact that, originally, the *Phil. Trans.* were not issued under the official imprint of the Royal Society, but were published privately by its secretary, to whom went any profits that might accrue from their sale. The first number of *Phil. Trans.* was published on March 6, 1665. Its editor was Henry Oldenburg, who, as Secretary of the Royal Society for some fourteen years, was responsible for the publication of the first 136 numbers. Oldenburg was a man of considerable zeal, and his volumes of *Phil. Trans.* included not only most of the items which were communicated to the Royal Society but also a variety of scientific matter that resulted from an extensive foreign correspondence. It was this correspondence that eventually landed him in the Tower, on a charge of carrying on political intrigues abroad. Fortunately his incarceration was brief, and he was soon released to carry on his useful work in the cause of science.

In the whole realm of scientific literature it would be difficult to find any books of greater interest than the early *Phil. Trans.*, which, unlike the modern volumes, contain a vast amount of interesting scientific matter that can be readily understood and appreciated by the layman. These were, of course, the early days of the Royal Society; a time when Charles II was showing a certain amount of interest in science and, indeed, had his own private "elaboratory". In those pioneer days, science was conducted for its own sake and, despite a state of almost continuous war, civil and otherwise, the scientists of the day were not feverishly engaged in devising new forms of destruction. It is true that an early volume of *Phil. Trans.* contains a paper entitled "Experiments for trying the force of great guns," communicated by Mr John Greaves, Savilian Professor of Astronomy at Oxford. This, however, appears to be a rather isolated instance of martial science.

The scientific records of those days as revealed by the *Phil. Trans.* make astonishing reading, and emphasise the extraordinary breadth of interest of the contributors. It would seem a far cry from those times to the present, when men are firing rockets at the Moon, and even considering the possibility of landing there. It may come as a surprise to some to learn that 17th-century literature is rich in material concerning the Moon and voyages thereto. An opera, entitled "The World in the Moon", was written in 1697, and apparently performed with much success and a great display of clever stagecraft. The Bishop of Chester, Dr John Wilkins, an original F.R.S., wrote, though not in the *Phil. Trans.*, "The Discovery of a World in the Moone: or, a Discourse Tending to Prove that 'tis possible there may be another habitable World in that Planet." He who reads these old *Phil. Trans.* will, at times, find himself straying off into the byways of additional reading wherein he will become acquainted with much of great interest: the Plague, the Great Fire of London, the lovely music of Purcell, the satirical plays and poems of Dryden—another original F.R.S. He it was who said of science that it "perfects genius, and moderates that fury of fancy which cannot contain itself within the bounds of reason".

It must not be thought that the interest of the old *Phil. Trans.* derives entirely from the work of the scientific men of the day. The period was full of pretty women in pretty clothes, many of whom were, in some way or other, connected with the world of science and with the men whose achievements are chronicled in *Phil. Trans.* For example, "Mad Madge", Duchess of Newcastle, was entertained on May 30, 1667, by the Royal Society, Hooke and Boyle being responsible for providing her with a demonstration of the new scientific toy—the microscope. She is probably less well known for being a dissentiate in the matter of the Moon's "borrowed light." In her "Blazing World" the following lines occur:

> "The moon was of a whitish colour; and although she looked dim in the presence of the sun, yet had she her own light, and was a shining body of herself, as might be perceived in moon-shiny nights."

She was yet another woman whose presence titillated Pepys, for, writing of her in his "Diary," he says:

> ". . . with her velvet cap, her hair about her ears, and many black patches because of pimples about her mouth."

SURGERY WITH WOODEN KNIFE

So far, in these notes, an attempt has been made to emphasise the great variety of interests which can be aroused by a study of the early *Phil. Trans.*, and to create what might be called an atmosphere of the times. We come now to a consideration of the volumes themselves. The Index of Authors is well worth scrutiny, for it contains not only the names of men who were foremost in the world of science—names such as Boyle, Newton, Hooke, Halley,

FIG. 1. Portrait of Henry Oldenburg (1626–77), by John Van Cleef, which hangs in the apartments of the Royal Society. He was one of the first secretaries (1661–7) and was responsible for the *Phil. Trans.*

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In the *SAVOY*,
Printed by *T. N.* for *John Martyn* at the Bell, a little without *Temple-Bar*, and *James Allestry* in *Duck-Lane*,
Printers to the *Royal Society*.
Presented by the Author May. 30th. 1667.

FIG. 2. Title page of Vol. I of the *Phil. Trans.* (*All illustrations here reproduced were made available by kind permission of the Council of the Royal Society*)

Wren, Wilkins, Ray, but other names which seem out of place in such distinguished scientific company. For example:

Mr J. Rose.—His Majesty's gardener at his Royal Garden at St. James'.

Mr J. Kunkle.—Gentleman of the bedchamber to the Elector of Brandenburg.

The published papers cover almost every conceivable subject, and many of them reveal an advanced state of learning. This is particularly noticeable in connexion with mathematics and astronomy. The work of the surgeons of the day, with fairly primitive instruments and an absence of anaesthetics is quite remarkable, but the agonies suffered by the patients must have been severe indeed. We read of tumours "cut away with a red hot knife" or with "a wooden knife soaked in *aqua fortis*".

The name of Robert Boyle is universally known, but not everyone will have read the actual account of his "Pneumatical Experiments". It is a paper of great interest and, although the squeamish might disapprove of the sufferings caused to the many different creatures subjected to treatment in the exhaust pump, schoolboys would probably be delighted by the experiments, and quite ready to forgive Boyle for the worry caused to them by his "Law". It is of interest to note that Boyle's exhaust pump was made for him by Robert Hooke, a man who has been described by Prof. Andrade as "probably the most inventive man who ever lived". He was the founder of scientific meteorology, inventor of the wheel barometer, hygrometer, and wind-gauge. He ranked high as an astronomer, architect, surveyor, and microscopist, and is considered one of the founders of modern geology. His name occurs frequently in the early *Phil. Trans.*, in connexion with a variety of subjects. It is not generally known that he invented that very useful mechanism, the iris diaphragm.

Boyle's contributions to *Phil. Trans.* are many and varied, and it is with some surprise that one finds him writing of such matters as "Grass in the lungs of Animals" and "A Monstrous Colt". His account of an earthquake at Oxford in January 1666 begins with the following quaint sentence:

> "Riding somewhat late betwixt Oxford and a lodging I have at a place four miles distant from it, I found the cold very piercing, which put me upon galloping at no very lazy rate."*

There is something to be said for introducing this friendly atmosphere into scientific writing.

Another illustrious name of the 17th century is that of Edmund Halley, who succeeded Flamsteed as Astronomer Royal (Astronomical Observator) in 1720. Although he is known to everyone for his astronomical work—particularly concerning comets—his seventy-four contributions to the early *Phil. Trans.* show a wide variety of interests. Naturally many of them deal with purely astronomical matters, but one is astonished to find him concerned with the subject of the identification of large teeth (elephant) which were unearthed in Kent in the year 1668. His paper, entitled "An attempt to find the age of the world by the saltness of the sea", is certainly ingenious, though it would hardly fit in with present-day ideas on geochronology. His theory was that, as the salinity of seas is due to salts washed into them by rivers, its rate of build-up could be ascertained by estimations carried out at long intervals of time. Having obtained this figure, and assuming the seas to have originally been fresh, a simple calculation would, in Halley's view, give the age of the Earth. The opening sentences of this paper are:

> "There have been many attempts made to ascertain, from the appearances of Nature, what may have been the antiquity of this Globe of Earth; on which, by the evidence of Sacred Writ, mankind has dwelt about 6000 years; or, according to the Septuagint, above 7000. But whereas we are there told that the formation of Man was the last act of the Creator, 'tis nowhere revealed in Scripture how long the Earth had existed before this last creation."

* Quotations and titles are taken from the *Abridged Phil. Trans.*, published by John Lowthorp, and in some cases the wording is different from that in the original papers. Boyle's account was of a calf. "Colt" is probably a misprint.

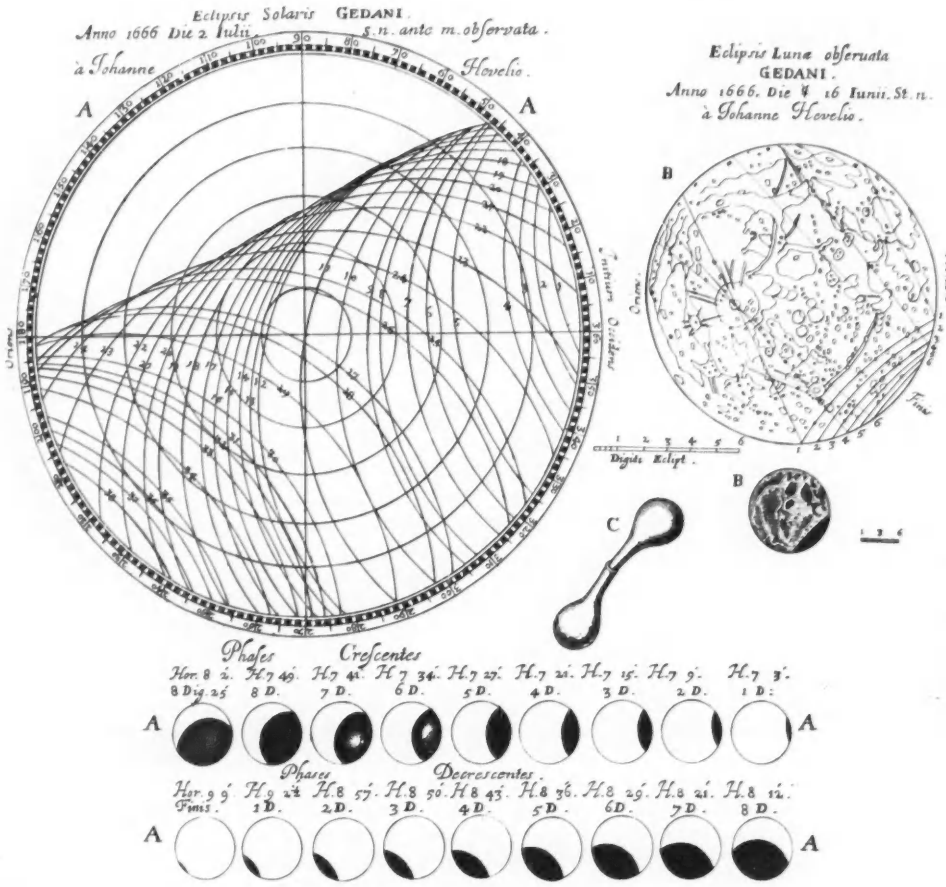
Eclipsis Solaris GEDANI.
Anno 1666 Die 2 Iulii. S. n. ante m. observata.
à Johanne Hevelio.
Eclipsis Lunæ observata
GEDANI.
Anno 1666. Die 4 16 Iunii. St. n.
à Johanne Hevelio.
Digiti Eclipt.
Phases Crescentes
Hor. 8 2'. H.7 49'. H.7 41'. H.7 34'. H.7 27'. H.7 21'. H.7 15'. H.7 9'. H.7 3'.
8 Dig. 25 8 D. 7 D. 6 D. 5 D. 4 D. 3 D. 2 D. 1 D.
Phases Decrescentes.
Hor. 9 9' H.9 22' H.8 57'. H.8 50'. H.8 43'. H.8 36'. H.8 29'. H.8 21'. H.8 14'.
Fmts. 1 D. 2 D. 3 D. 4 D. 5 D. 6 D. 7 D. 8 D.

FIG. 3. Vol. I, p. 385 (*Anno* 1665 and 1666). From a paper entitled, "For Observing the Eclipses of the Moon, free from the Common Inconveniences, as it was left by the learned Mr Rook, late Gresham-Professor of Geometry."

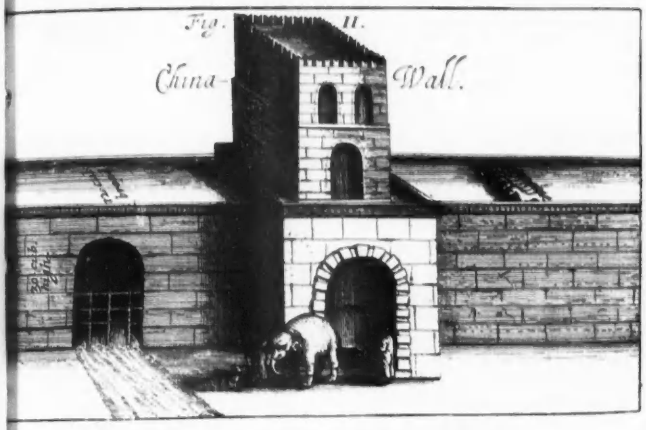

FIG. 4. Vol. II, p. 473 (*Anno* 1667). Illustrating a book review entitled, "Account of Athanasii Kircheri CHINA ILLUSTRATA". (A. Kircher went to China in 1656, reached Peking, and returned two years later. The unsigned review may well come from H. Oldenburg.)

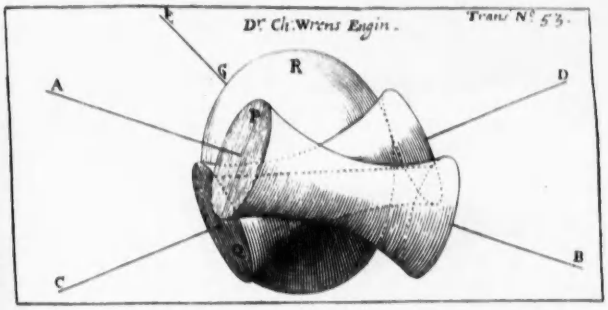

FIG. 5. Vol. IV, p. 1059 (*Anno* 1669). "A description of Dr Christopher Wren's Engin, designed for grinding Hyperbolical Glasses; as it was in a manner promised Numb. 48, p. 962." (The paper itself, written in Latin, is only one page long.)

DEATH AND DISSECTION

Under the heading of Zoology, the *Abridged Phil. Trans.* contain many papers, of which some are remarkable. One of the most interesting is that on "The Anatomy and Osteology of an Elephant", by Patrick Blair, M.D., F.R.S. It is a very lengthy paper and gives an astonishingly detailed description of the organs and bones of the creature that was apparently part of a travelling circus. It commences:

> "After this animal had travell'd most part of Europe, she came at last to Scotland, where after some stay at Edinburgh, they conducted her to the north, and by long and continued marches hasten'd to Dundee in their return; the beast much fatigued fell down within a mile of Dundee. After many endeavours (which proved ineffectual) to get her upon her feet again, they digg'd a deep ditch, to the side of which she might lean to rest herself; but soon afterwards there fell great rains; so that after lying a whole day in water, she died the next morning, being Saturday the 27th April 1706."

There is something rather pathetic about a remark appended to the account. It says:

> "Fig. 60 represents the stuff'd skin of the elephant as it now stands in the Hall at Dundee."

There is much of interest—even of fascination in the old *Phil. Trans.*, and it is a pity not to be able to include it all. For instance, one would like to include the contributions of Christopher Wren, so well known as the architect of St Paul's Cathedral and many other fine buildings, but less well known for his pioneer work on blood transfusion. There are papers by the renowned Italian microscopist Marcello Malpighi, who was so concerned with the structure of minute living things. Sadly enough, in one volume of *Phil. Trans.*, there occurs a paper by Jean Marie Lancisi, Professor of Anatomy at Rome. Its title is "The Death and Dissection of S. Malpighi." It is a gruesome and rather morbid work.

Much could be said about the medical papers, some of which make very curious reading. There are several records of "Siamese Twins" usually joined at the breast. None of these seem to have survived and, although the surgeons carried out very thorough *post portem* examinations, there does not appear to have been any attempt at separation during life.

Entomology was becoming a separate science, and many of the papers dealing with insects show great observational power on the part of the authors, of whom the greatest was undoubtedly Martin Lister. He it was who wrote accurately on the subject of the parasitisation of caterpillars by ichneumon flies, and it is of interest to note that he concerned himself with that pest of the market garden—the larva of the Large White Butterfly. Here are his words:

> "'Tis true, the swarms of these ichneumons, coming out of the sides of caterpillars, do immediately make themselves up into bunches, and each particular theca (from the cabbage caterpillar for example) is wrought about with yellow silk."

Those who grow cabbages will recognise the accuracy of this description.

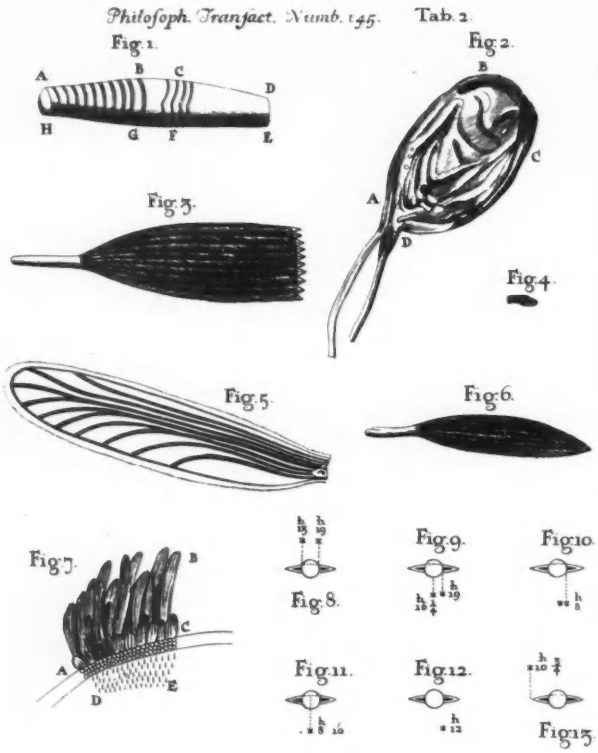

FIG. 6. Vol. XIII, p. 80.

Referring to "An Abstract of a letter from Mr Anthony Leewenhoek writ to Sir C. W., Jan. 22, 168⅔ from Delft".

Fig 1. "*ABCDEFGH* is the description of the Filament of a Flea broken out of the breast, . . ."
Fig. 2. "*ABCD* is the Testicle (of a Flea) . . ."
Fig. 3. "The feathers of a gnat."
Fig. 4. "Wing of a gnat as it appears to the naked Eye."
Fig. 5. "*ABC* is the same (wing of gnat) represented . . . in a larger proportion."
Fig. 6. "Feates of the wing of the gnat."
Fig. 7. "Small haires of the wing of a gnat *ABC* are the feathers, *ABEC* are the haires on the film."

Fig. 8–Fig. 13.

Referring to "A Correction of the Theory of the Motion of the Satellite of Saturn, by that ingenious Astronomer Mr Edmund Hally."

NEWTON V. PARDIES

Our final selection from *Phil. Trans.* shall be the famous paper of Newton—"A New Theory about Light and Colour". It was published in the year 1672 and commences:

> "In the year 1666 (at which time I applied myself to the grinding of optic glasses of other figures than spherical) I procured me a triangular glass prism, to try therewith the celebrated phaenomena of colours. And in order thereto, having darkened my chamber, and made a small hole in my window-shuts, to let in a convenient quantity of the sun's light, I placed my prism at its entrance, that it might be thereby refracted to the opposite wall. It was at first a very pleasing divertisement, to view the vivid and intense colours produced thereby."

This paper is of interest not only because of its importance as a contribution to science, but for the disputation it brought about between Newton and Father Ignatius Pardies. It seems that the latter gentleman by no means agreed with Newton's theory as to the production of the spectrum, and referred to it as "an Hypothesis". Newton took exception to this and politely suggested that Pardies just did not understand:

> "Now as to the Reverend Father calling my theory an hypothesis, I take it not amiss, because to him it may not yet appear."

In reply, Pardies apologises:

> "And that I called his theory an hypothesis, I did it without any design, but made use of the word that first occurred."

However, all ended happily, with Newton saying:

> "As to the Reverend Father calling our doctrine an hypothesis, I believe it proceeded from nothing else but he used the word which first occurred to him."

And Pardies, in reply:

> "Mr Newton's last answer to my objections has entirely satisfied me."

Reading the whole thing one gets the impression that, at times, the argument became heated, but tempers were never frayed and perfect courtesy reigned throughout.

And here, this story of the old *Phil. Trans.* must end with the hope that these brief notes will have been sufficient to bring about a realisation of the pleasure and interest that await the reader. The volumes are not easy of access unless, of course, one happens to be a Fellow of the Royal Society. There are, however, quite a number of abridged editions, and it is likely that some of these volumes are to be found in public libraries. These abridgements are occasionally listed in the catalogues of second-hand booksellers and, anyone wise enough to purchase them will have made a wonderful investment. For complete appreciation of these books one needs to have some knowledge of 17th-century history, for this makes it possible to realise the conditions under which so much brilliant pioneer scientific work was carried out. A summary of the achievement revealed by the *Phil. Trans.* is very impressive, but there is another side to the picture. The 17th century was a period of transition from crude theory and superstition to experimentation and exact science and, for a time, the two phases existed side by side. At the time when the *Phil. Trans.* were recording the brilliant work of such men as Boyle, Newton, Halley, Wren, and Hooke; when Martin Lister was making his accurate observations on ichneumons, there were still to be found astrologers, and alchemists who claimed to have discovered the Philosopher's Stone and by means of it to transmute base metals to gold. Men who should have known better, still believed in witchcraft, and were content to condemn alleged witches to death by burning. "Pepys' Diary" tells us that, for those who liked it, there was always the public spectacle of men being hanged, drawn, and quartered. It is well to bear these things in mind when assessing the progress of science during the "Golden Age".

BIOCHEMICAL ENGINEERING IN THE FOOD INDUSTRY

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In the preparation of foods and beverages, most micro-organisms must be repressed to avoid spoilage, and a few encouraged for flavour and other distinctive characteristics. The application of micro-biology to industrial production has led to a new subject called biochemical engineering.

Biochemical engineering is a relatively new term and has become accepted as a university subject only during the last few years. Its significance can best be explained by reference to its parent subject of chemical engineering. This embraces all chemical industries and concerns the study of processes in terms of chemistry, physical chemistry, and physics, with the object of designing new equipment and getting the best out of existing plant. The method involves grouping processes into "unit operations", thus, distillation or filtration are investigated from their fundamental and practical aspects for application in the widest possible range of industries, and in conjunction with associated equipment and services.

Because the field of chemical engineering is already so broad, and because the majority of men entering it have only a rudimentary background of the biochemical sciences, it cannot easily cater for the more specialised requirements of the biological industries. These industries already amount to a significant fraction of our economy and promise to expand appreciably. Broadly, they can be said to include all industries using biological raw materials (as distinct from mineral) or using biological processing methods. To keep the list within manageable proportions it is reasonable to limit the range to materials in which active micro-biological or enzymic systems are still present. Thus the retting of flax would be included as this consists of a controlled anaerobic fermentation of the whole stems, but linen weaving would not as the fibre is inert at this stage. If, however, through bad storage conditions, mould growth develops, then biochemical engineering would regain its interest.

Many aspects are common to both chemical and biochemical engineering, although the balance or emphasis may be different. Thus, in biochemical engineering, distillation is less important, while filtration must be extended to apply to colloidal, gelatinous materials. Most important, however, is that all operations must be viewed against a background of biochemistry, biophysics, and micro-biology. Almost all biological materials require delicate treatment by reason of their build-up of proteins and other complex structures; equally, they provide a ready foundation for the growth of micro-organisms. Quite often, precautions must be taken to avoid microbial spoilage, but at other times, micro-organisms must be encouraged to bring about desirable changes, and in many cases, equipment, treatment, and processes must be designed to inhibit the activities of all organisms except for one special strain which must be allowed to multiply.

SIGNIFICANCE OF ENZYMES

Most living processes are catalysed by enzymes, present in all forms of living materials, often combining structural significance with catalytic activity and amounting to a high proportion of the total matter. About 700 have so far been clearly described of which about 100 have been obtained in crystalline form. They show great variety, but without exception prove to be proteins, many of which cannot exert their catalytic power unless accompanied by co-factors which can range from simple metallic ions to complex nucleotides. Although enzymes are absolutely essential to life, they are themselves not living, but can bring about their specific reactions outside living systems. This is of great significance in the food and beverage industries, since on the one hand, degradative reactions can proceed in the absence of life, and on the other, enzymes can be extracted from one system and usefully employed on another non-living one.

It is clear from this digression that biochemical engineering must include a number of aspects not usually included in chemical engineering and where possible it is advantageous to group them into unit operations applying to all industries. These in particular would include many functions of hygiene and sterilisation, or the control of micro-biological and enzymic reactions by means of heat and cold, filtration, disinfectants, dehydration, lyophilisation and various radiations, with application to materials as varied as air, milk, meat, and grain in the food group, and vitamins, vaccines, antibiotics, "cat-gut" for sutures, and industrial solvents in other fields. In addition, micro-biological processes are very widely used for effluent purification, not only from biological systems but also from gasworks and coke ovens, where these versatile organisms are induced to oxidise even phenols and cyanides to non-polluting compounds.

MILK PROCESSING

Heat transfer, one of the corner-stones of chemical engineering, has special applications in food processing, including not only the design of hygienic heat exchangers for milk and other fluids but also the very large fields of canning, cold storage, and freezing. As a pointer to this, it is claimed that in 1958, of all peas sold in this country, 75% were canned, 13% frozen, and only 12% sold in the pod.

Milk pasteurisation has been a legal requirement for several years in Great Britain and the equipment for it has evolved from batch processing at 145°F./30 mins. to continuous High Temperature Short Time (HTST for short) plant operating at 162°F./15 secs. with fully automatic control and maximum use of regenerative heat. These conditions are extremely strict and must be applied to literally every drop of milk; if the milk is under-pasteurised, viable pathogenic bacteria, particularly bovine tuberculosis, can survive, and if over-pasteurised the palatability, nutritional value, and "cream line" are impaired. In addition, such plant must be fully hygienic, which now means being easily dismounted for cleaning by hand, but may well evolve to a Cleaned-In-Place (CIP) system which can be completely cleaned and sterilised *in situ*; this itself represents a delightful problem in biochemical engineering, requiring metals able to stand the strong chemicals necessary to remove "milk stone" and also probably to make the whole sterilising process automatic, all without involving prohibitive cost. Such problems, incidentally, apply throughout the dairy and ice cream industries, and indeed to all biological liquid handling systems. It is estimated that the application of a CIP system will drastically reduce present overtime cleaning costs.

In the broadest sense, the manufacture of butter is the outstanding case of an industry's having moved almost completely from the farm-house to the factory in most of the Western world and this is reflected in the replacement of heterogeneous products by a highly standardised range. The obvious technical change has been in replacing the domestic bowls and the hand churns of the farm with large, power-driven, mainly stainless steel equipment, firstly on a batch system and increasingly with continuous plant. A much more fundamental change, however, has been in the control of flavour of butter and other products by deodorisation and selection of bacterial strains and control of their activity. Under farm conditions, the separated cream was allowed to mature or "ripen" as a result of its fortuitous blend of microbial flora and the flavour of the final product resulted from a combination of the original milk flavour (often including weed flavours) and the products of this ripening. The result was superb at times and poor at others and the butter had only a limited shelf life.

With modern technical control, the cream is often exhaustively deodorised, always pasteurised, and usually matured with a selected blend of micro-organisms chosen for their ability to give the correct balance of lactic acid and diacetyl type flavours during the ripening operation. Curtailment of this stage can produce a very bland neutral butter which has a long storage life but little else to commend it. On the other hand, if all stages are controlled with flavour in view an excellent and uniform product can be made, but which must be used within a few weeks. The manufacture of cheese is tending to follow the same type of development, with similar equipment, methods, and control of micro-organisms; but in this case the time taken for the development from milk to mature cheese is measured in months rather than hours and this sets certain limits on continuous processing. There is still much to learn about the biochemistry of cheese making, but further research will probably lead to the possibility of accelerated ageing techniques. On the other hand public preference may veer away from the traditional cheeses in favour of the lightly flavoured pasty cheese blends which could probably be made without long maturation.

CANNING AND FREEZING

Canning is a quite different field, and in this case it is necessary to apply sufficient heat to ensure that no viable organisms exist anywhere in the can. In practice this is interpreted to mean that none can develop in the product at 100°F. for one year. The danger lies with a range of spoilage organisms, but especially with spores of *Clostridium botulinum*, which are heat resistant and which can, under suitable conditions, develop anaerobically to produce an intensely poisonous toxin. Experimental "thermal death curves" are obtained which relate the time and temperature necessary to destroy this or similar organisms for each product, and the results are translated to industrial practice.

Products vary widely, from acidic fruits which in any case inhibit bacterial growth, to near-neutral mixes ranging from thin soups, through pastes to solid meat and fish packs, and including difficult items such as large chunks of meat in thin gravy. For many of these products it is not easy to apply normal calculations of thermal diffusivity and resource must be made to empirical methods with the full realisation that excessive cooking will spoil the quality of the product. With solid packs, it is, in fact, unavoidable that the outside is overcooked to ensure adequate treatment of the centre.

Numerous attempts are now being made to overcome such problems. Perhaps the most widely useful is the system of sterilising liquid or semi-liquid products in a heat exchanger system and then putting them into previously sterilised cans under sterile conditions; for acidic packs, this can be highly satisfactory and has the outstanding advantage that material in large containers suffers no more heat damage than in small. The main trend of development in canning, however, is towards fully continuous instead of batch processing. This gives opportunity for controlled rotation or agitation of the cans to give maximum heat transfer.

While, with some products, the prolonged cooking during canning produces desirable flavours and textures, there are many in which either no cooking is required or the housewife prefers to do her own, and the current popularity of deep-frozen foods reflects this preference. The essence of this method is in many ways the reverse of canning, in that the least possible cooking is applied at the factory, usually only to inactivate damaging enzymes and with no attempt to kill all the micro-organisms. The food is then quickly frozen and thereafter held in this state till used, to inhibit microbial growth and residual enzymic spoilage. It should be noted that these reduced temperatures are not in themselves bactericidal.

For maximum quality, it is not only essential that the original material is clean, fresh, and of high general grade, but also that freezing and subsequent storage are such that the least possible damage to cellular structure or protein is brought about. Ice crystals can physically crush or puncture cell walls and, as the ice crystallises out, it can leave high

salt concentrations in the liquid phase sufficient to denature or precipitate proteins and other delicate compounds. In most cases, very rapid freezing to a low temperature followed by steady maintenance at this level gives the best results, but such ideals are not always achievable commercially throughout the process, transport, and storage chain, and it is not altogether surprising that deep-frozen packs from retailers often show texture defects.

Similar problems are encountered in ice-cream, which leaves the factory with ice crystal size well below detectable limits but when purchased, may have clearly defined crystals half an inch long. Clearly, once the product has left the factory, biochemical engineers can do no more than give advice, although inside the factory itself, they take keen interest in all problems embracing handling and preparation as well as actual freezing. Again the present trend is towards continuous processing techniques, by which the same production line may well be dealing with a series of seasonal commodities and therefore must be widely adaptable.

CHILLING AND COOL STORAGE

Preservation by chilling, rather than actual freezing, also has wide uses and can retain somewhat better quality, but only for a limited period of perhaps up to eight weeks in the well-known large-scale application to meat. All types of British meat and particularly beef from the Argentine are preserved by this technique and it may be extended to other countries with the advent of fast shipping. If such meat is held at a very precisely controlled temperature—on the verge of freezing—it attains absolutely prime condition with just the correct amount of enzymic tenderising, but it is, of course, essential to maintain these conditions right up to the time of use. Biologically speaking, one of the most interesting uses of chilling is the storage of fruit, including apples, pears, and bananas, which makes use of the principle that reduced temperature will slow down all reactions, including respiration. If, in addition, respiration is further depressed by allowing carbon dioxide to build up—an effect in line with the laws of mass action—these two controls can be carefully balanced to suit the particular fruit and the final ripening or climacteric can be delayed for many months. Another interesting point is that traces of ethylene act catalytically in triggering some aspects of ripening, but unless used with care can produce fruit of excellent appearance but no flavour and poor texture.

For millennia, man has made use of micro-organisms and associated enzymes in the preparation and preservation of food and beverages and has learnt how to control their activities. During the last few decades we have seen these processes gradually transferred to large-scale factory production, with the accompaniment of ever-expanding technologies. By its inheritance, much of the accumulated knowledge is of an empirical nature, but this is now being blended with detailed biochemical and micro-biological information, which is enabling a wider range of products to be made with lower cost and wastage. Joint application with other methods of preservation has also proved useful, for example, cool storage of smoked fish and bacon enables milder cures to be adopted to suit modern palates; previously, to ensure prolonged keeping, it was necessary to salt heavily and to smoke for a long period to bring about considerable dehydration combined with an extensive deposition of resins and wood decomposition products to act as preservatives.

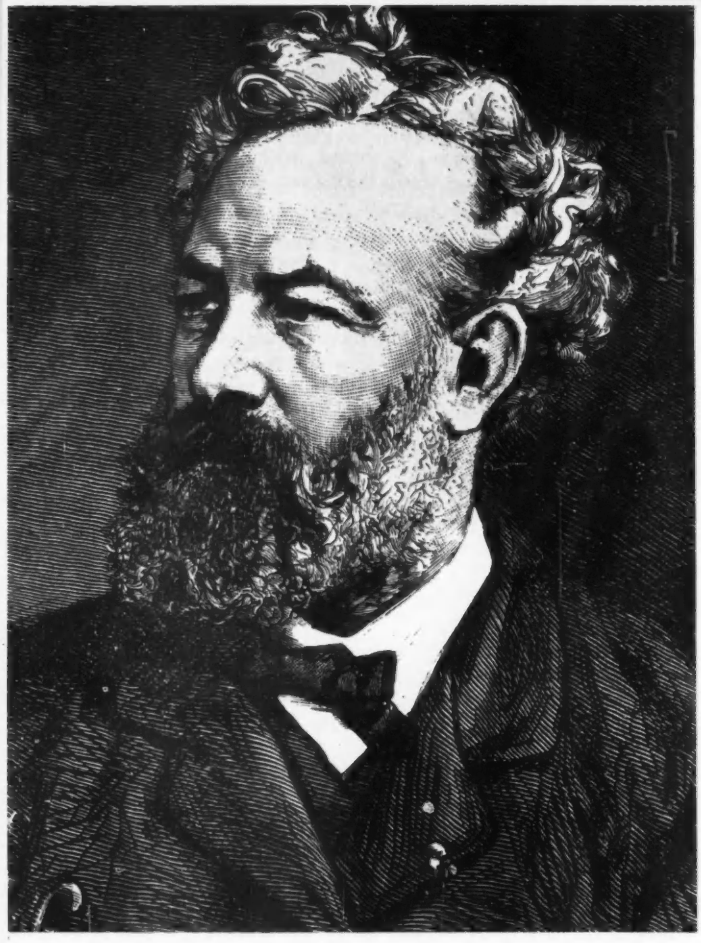
BEVERAGES

We cannot leave this subject without at least mentioning beer, wines, spirits, non-alcoholic fruit juices, and other beverages. A number of people have a suspicion that the unique quality of European château and farm-house wines may have something to do with the mixed microbial flora associated with bullock carts and treading the grapes with bare feet, and that the modern tendency to replace these with tractors and stainless steel equipment is sounding the death knell to these products. On the other hand, yeasts for all purposes have received intensive study recently and strains can be provided for making uniform batches of any alcoholic fermentation and should make large-scale producers independent of variations of flora from year to year.

The brewing of beer is also receiving a great deal of attention now from many viewpoints. Attempts are being made to increase the shelf life in bottle and can, to meet a growing demand for lager type beer instead of "top brewed ale", and to develop, if possible, continuous processing. Non-alcoholic fruit juices are gaining in popularity too, both as refreshment and as flavours for other commodities and it is interesting to comment that because the public insist on a cloudy squash, expressed juice has to be rapidly pasteurised to destroy clarifying enzyme systems. Conversely, apple and other juices are preferred crystal clear, so enzymes have to be added to clarify them.

Biochemical engineering acts as a clearing house for all these ideas of quality and storage life, and translates consumer demand into industrial production at the lowest cost. It is clear that anyone trained in this field can look forward to a fascinating life of unlimited future. It carries with it also a deep-seated satisfaction of working with living material and processing it to a form of direct value to the well-being of mankind.

A final comment regarding available literature may be of interest to readers who wish to pursue this subject. There are a fair number of books dealing with chemical and microbiological aspects of food production, but none specifically from the viewpoint of biochemical engineering. Those nearest to this are directed to the technologies of separate industries, and in many of these the maintenance of so-called "trade secrets" limits their value so that they do not seriously reflect the advanced current practice. Perhaps the most useful publications are those issued by HMSO from various government research departments, including comprehensive annual abstracts. In addition, the Society of Chemical Industry have active food and microbiological sections which organise meetings and symposia, and several industries support their own research establishments. A similar pattern can be seen in various members of the British Commonwealth and the U.S.A., and articles on food topics can be found not only in journals specially devoted to this subject, but also widely dispersed in those covering aspects as diverse as refrigeration and the uses of nuclear energy.



JULES VERNE'S EXTRAORDINARY SCIENTIFIC VOYAGES

ANTHONY R. MICHAELIS, Ph.D., B.Sc.

By combining great imagination with a logical approach to the subject, Jules Verne was able to predict accurately many recent technological developments; the basis for his predictions is examined.

FIG. 1. Jules Verne, the author of over sixty books, was born at Nantes in 1828 and died at Amiens in 1905. In spite of the fact that in his works he deals with all parts of the Earth, and even beyond, he hardly travelled at all himself; he once crossed the Atlantic on the *Great Eastern* and sailed his yacht *Saint-Michel* around Mediterranean and North African shores.

Man has always longed to know the future. Surprisingly often his guess turned out to be correct. The old tribesman could predict from his experience that if rain fell at certain times, good pasture and ample food would follow. The Egyptian astronomer could predict the dates of eclipses, and the modern chemist can predict with absolute accuracy the results of adding an acid to an alkali; the whole trend of scientific research has been to establish certain laws of nature, from which—within narrowly defined limits—the exact course of future events can be foretold.

But to prophesy the future without a detailed knowledge of the relevant laws has been to many a more profitable occupation. To paint pictures of animals in caves and foretell successful hunting, to predict the end of the world at the year A.D. 1000, and to forecast the fate of an individual from the position of the stars, are merely the results of hopes and fears. They have no possible scientific basis.

SCIENCE AND FICTION

Within recent times, a third type of prediction has become possible. The regular and rapid growth of scientific knowledge has sometimes allowed an extrapolation from known laws, and permitted an accurate forecast following a logical sequence of discovery and development. It was in this third kind of prediction that Jules Verne was the first, if not the foremost, of all who have followed this path.

One hundred years ago, in 1860, Jules Verne started to collect two large piles of notes in his fifth-floor attic in the centre of Paris, one labelled fiction, the other science. Born in 1828 at Nantes, he had at the age of 31 achieved very little; a number of his mediocre operettas had quickly flitted across the Paris stage, and he gained a meagre living from his speculations on the Paris Bourse. However, his imagination roamed widely and his thirst for accurate knowledge was endless; he spent every free moment reading and recording in his piles of notes an ever-growing fund of ideas and facts. It was not until two years later, in 1862, that he submitted a series of essays about Africa, to a publisher named Hetzel. Hetzel was both a great editor and a creative artist who saw in this unknown writer a story-teller of quite exceptional merit. Rewritten and unified, these essays, a combination of his two piles of notes, were made into the world-famous narrative of "Five Weeks in a Balloon". It was first published in 1863 and with its combination of lucidity and modern precision of detail, it set the stage for the sixty-three volumes of "Extraordinary Voyages" which flowed from Jules Verne's pen until his death in 1905.

In "Five Weeks in a Balloon" Verne tried to solve the contemporary problem of a dirigible balloon. His solution was at once impracticable and highly dangerous. Electricity from accumulators decomposed water into oxygen and hydrogen, and these were burnt in an oxy-hydrogen flame to heat the gas in the balloon; thus the balloon, the *Victoria*,

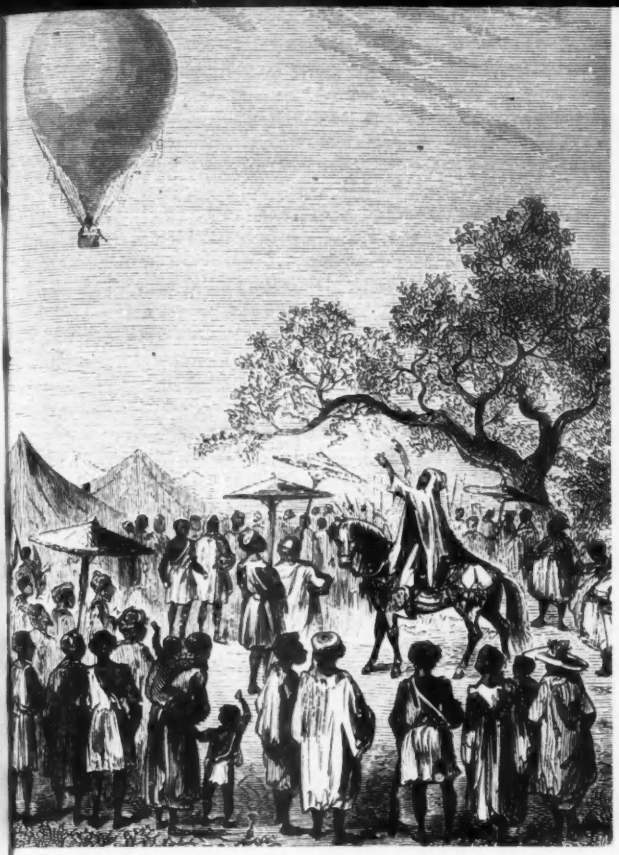


FIG. 2. Dirigible balloon flight across Africa was the earliest of Jules Verne's many stories. By expanding and contracting the hydrogen in the balloon, the navigators could choose the most appropriate winds for their flight. Here the natives of Kernak, just south of Lake Chad, greet the balloonists. From "Cinq Semaines en Ballon", 1863.

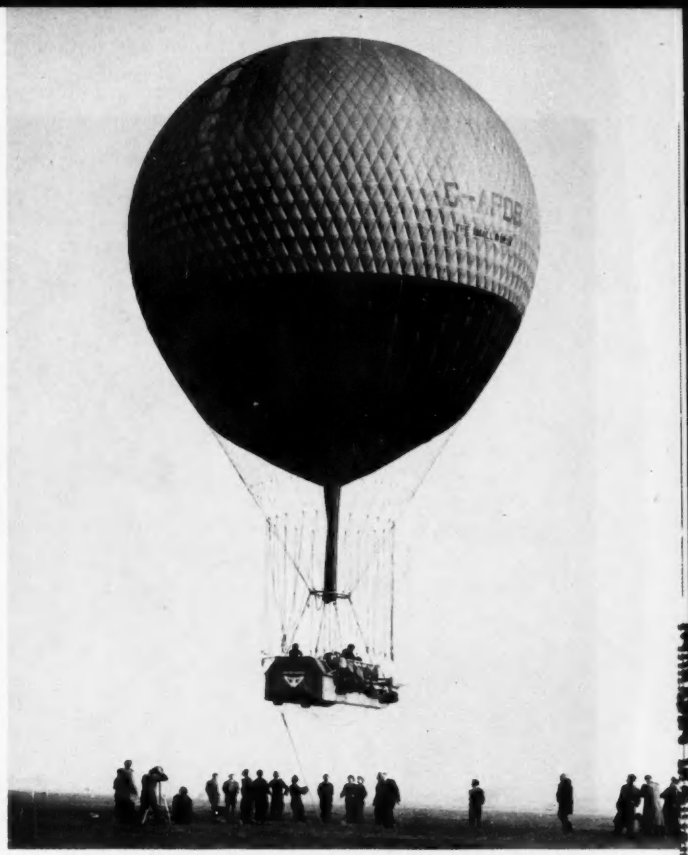


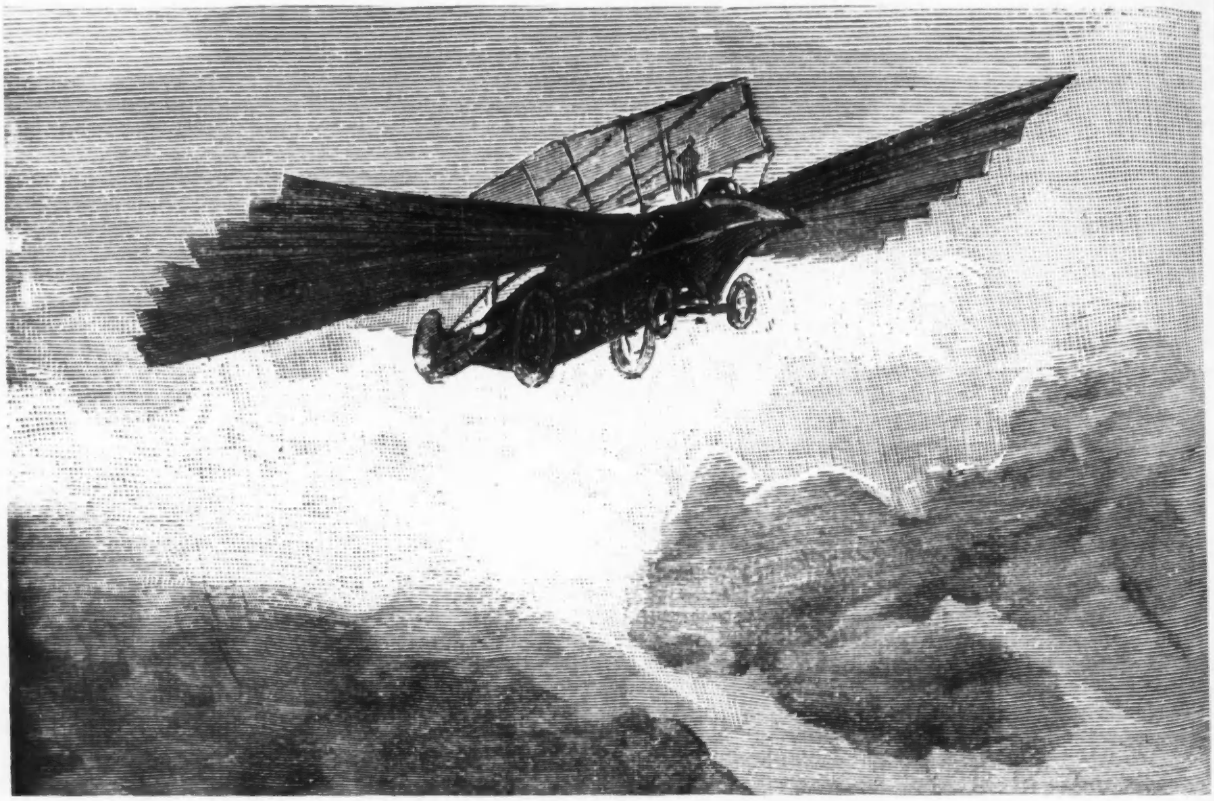
FIG. 3. The *Small World*. The *Small World* balloon rose from the ground for its first anchored flight at Cardington in November 1958.

was made to rise and could choose the most suitable winds for its flight across Africa, from Zanzibar to the Senegal, in a westerly direction. The discovery of the source of the Nile, only a year prior to publication of the book, was told in it for the first time to the public. Incidentally, it was only in January 1959 that the crossing of the Atlantic in a westerly direction by the British balloon *The Small World* demonstrated that really long voyages by means of a balloon are possible, though hardly practicable.

In 1886, twenty-three years after publication of "Five Weeks in a Balloon" Verne returned to the theme of aviation, in his tale of "Robur le Conquérant" with his aircraft the *Albatros*. By then Verne had correctly realised that aviation could only succeed through an aircraft heavier than air and driven by powerful machinery. The *Albatros* was constructed entirely from plastic material (laminated paper to form a light and yet tough substance) and suspended in the air by seventy-four small counter-rotating helicopter screws; it was driven forward by two large propellers, one mounted fore, the other aft of the ship-like structure, which measured 30 m. (100 ft.) in length and 4 m. (12 ft.) in width. A maximum speed of 200 km./hr. (125 m.p.h.) could be achieved, again using powerful electric accumulators as the primary source of energy. Thrilling adventures were told of aerial survey, air-sea rescue operations, air-to-air combat and the use of dynamite bombs. The achievement of such a speed by a combined helicopter and propeller-driven aircraft has again only in recent months been realised by the British Fairey Rotodyne; in January 1959 it set up a world record of 307 km./hr. (191 m.p.h.). The use of electricity for aircraft propulsion lies yet in the future and may only be achieved when nuclear power, perhaps as thermo-nuclear fusion, has been suitably adapted.

Another of Jules Verne's aircraft must be mentioned, the *Epouvante*, described in his tale, "The Master of the World" which was published in 1904 and written probably before the news of the Wright Brothers' first flight had reached Paris. The *Epouvante* was a triphibious craft, equally fast and powerful on land, on and under the sea, and in the air; it also possessed electrical machinery. In flight it was sustained by large flapping metallic wings, a true ornithopter; during land and sea travel the wings were folded back into the craft itself. Such a vehicle has as yet to be constructed and if and when this does occur, one can only hope that it will not be captained by a modern Robur who in Jules Verne's story set himself against all the forces of law and order of the world.

Thus, in the field of aviation, Jules Verne has gallantly tackled the problems of his own time with the dirigible balloon *Victoria*, has accurately foretold much of the future with the rotodyne *Albatros* and has described a triphibious craft, the *Epouvante*, which has yet to be built.



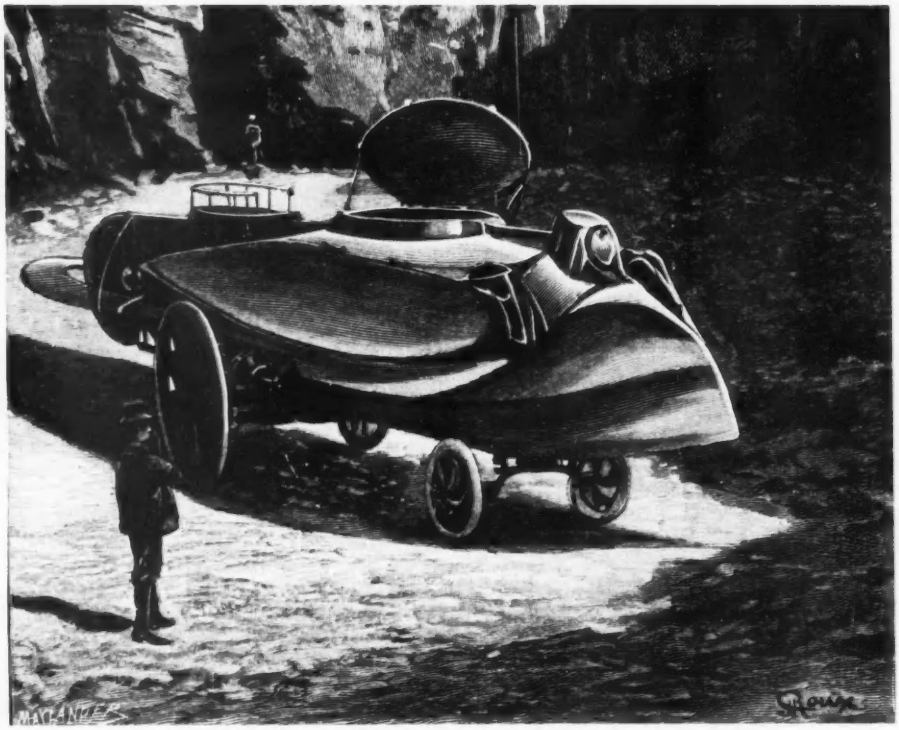


FIG. 4 (*above*). The *Epouvante* was a triphibious craft. Here seen flying, it propelled itself by beating its wings; in fact it was a true ornithopter. From "Maître du Monde", 1904.

FIG. 5 (*left*). The *Epouvante*, imagined by Jules Verne as a triphibious craft, is shown in this drawing by G. Roux stationary on the ground; its wings are folded back when travelling on land and under water, although its under-carriages could apparently not be retracted. From "Maître du Monde", 1904.

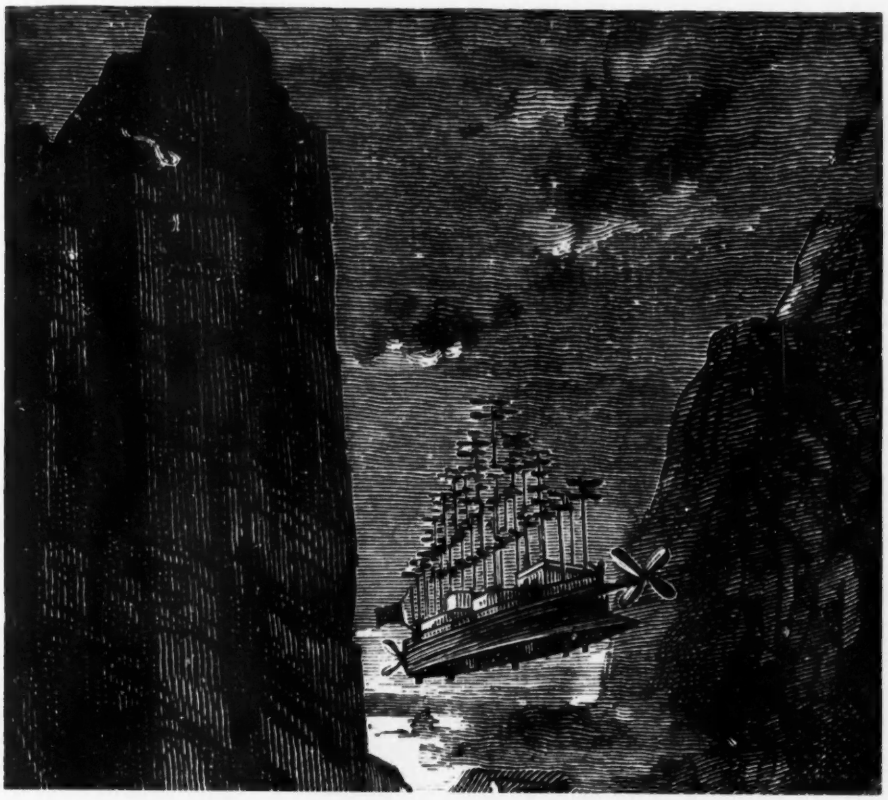
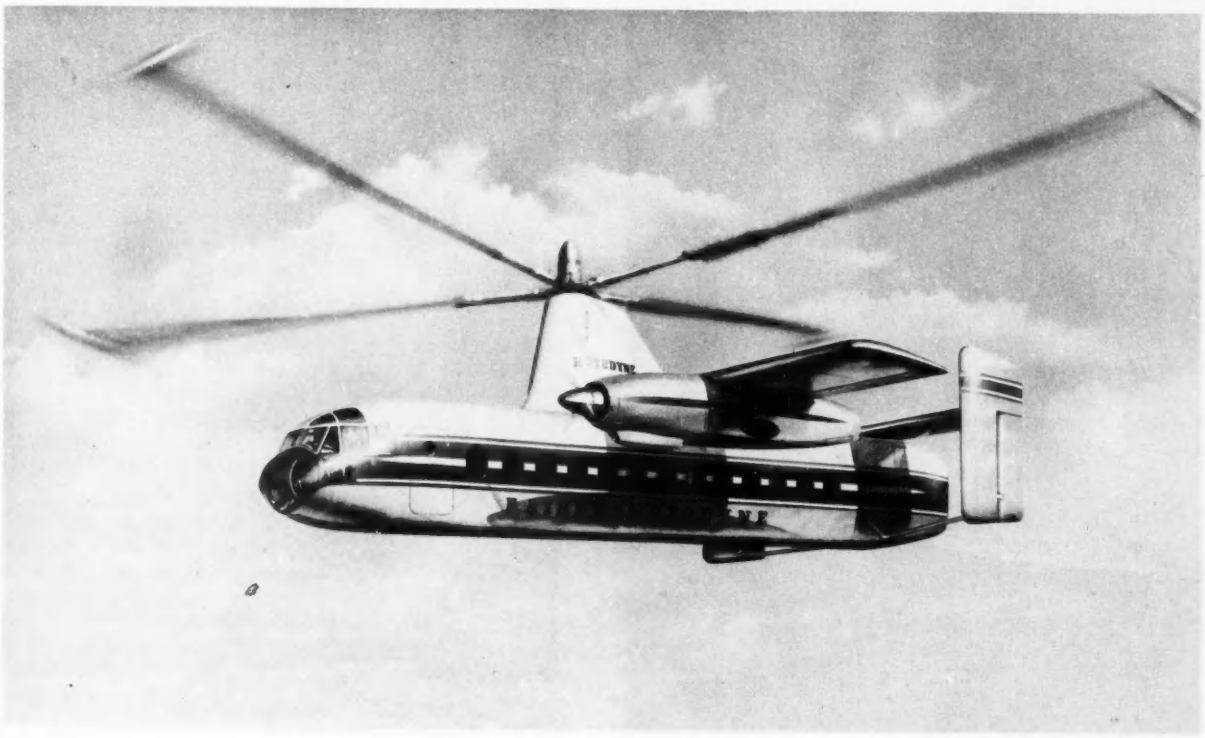


FIG. 6 (*right*). Helicopter flight through the Rocky Mountains was described by Jules Verne; here the *Albatros*, suspended from seventy-four counter-rotating blades and propelled by one fore and one aft propeller, navigates easily through a difficult passage. From "Robur le Conquérant", 1886.

FIG. 7 (*below*). The Fairey Rotodyne with Rolls-Royce Tyne engine.



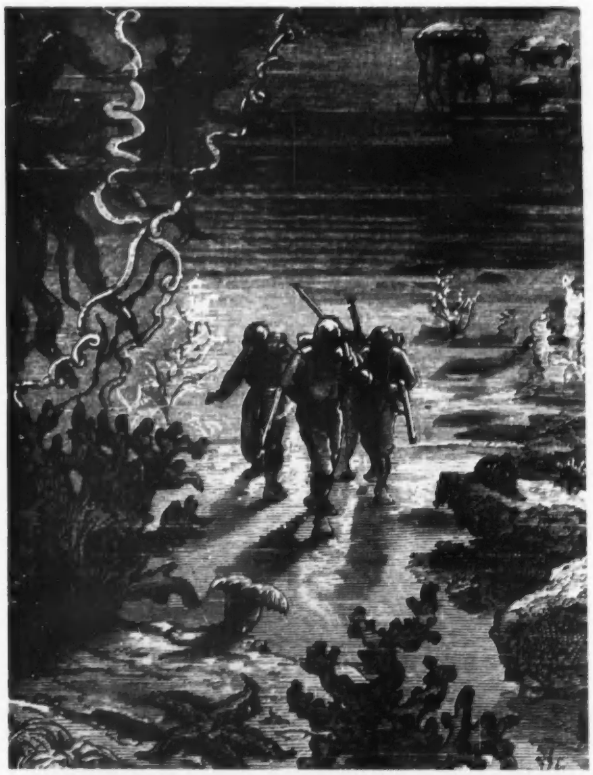
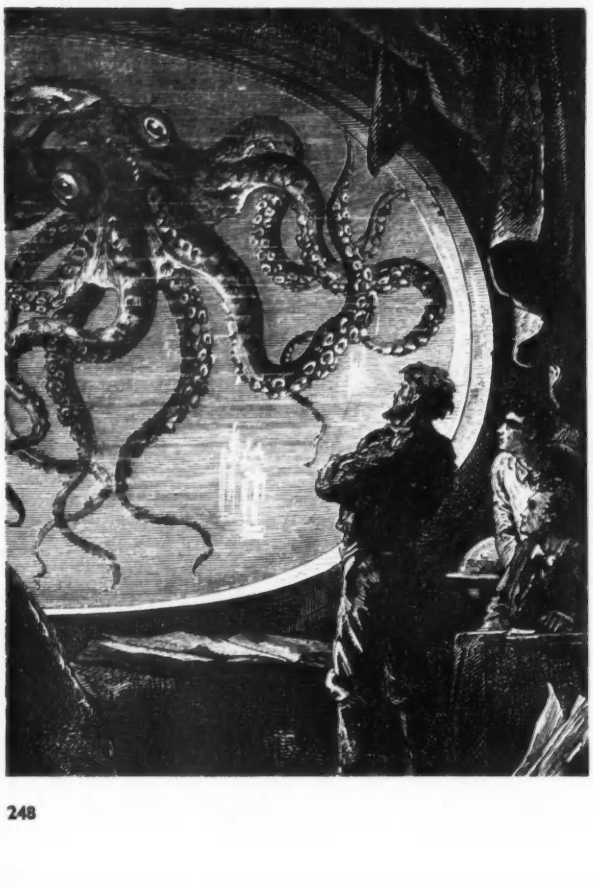


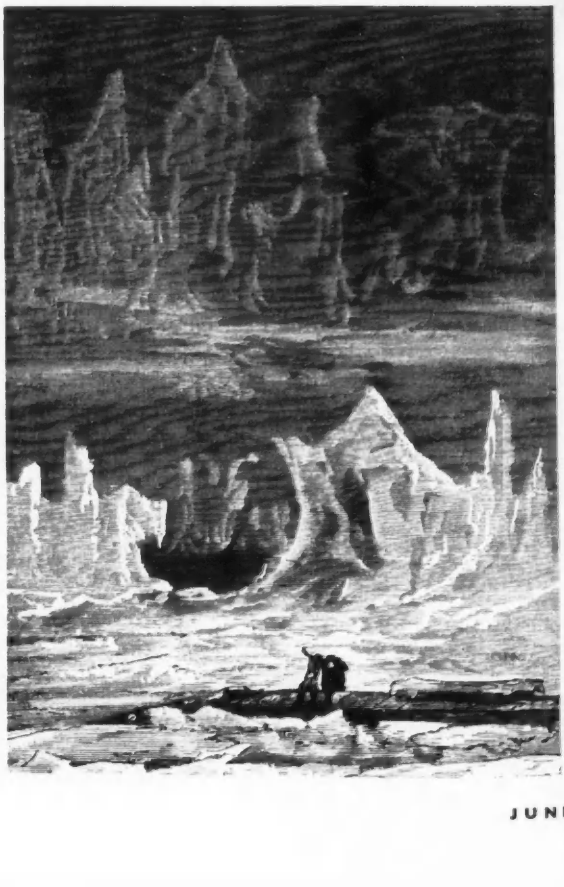
FIG. 8. Underwater exploration by Captain Nemo, Prof. Aronnax of the Natural History Museum of Paris, and members of the crew of *Nautilus* near the imaginary island of Crespo in the Pacific Ocean. The diving equipment, modelled on that of Rouquayrol-Denayrouse who described it first in 1865, is the true precursor of the modern aqualung. From "Vingt Milles Lieues sous les Mers", 1870.

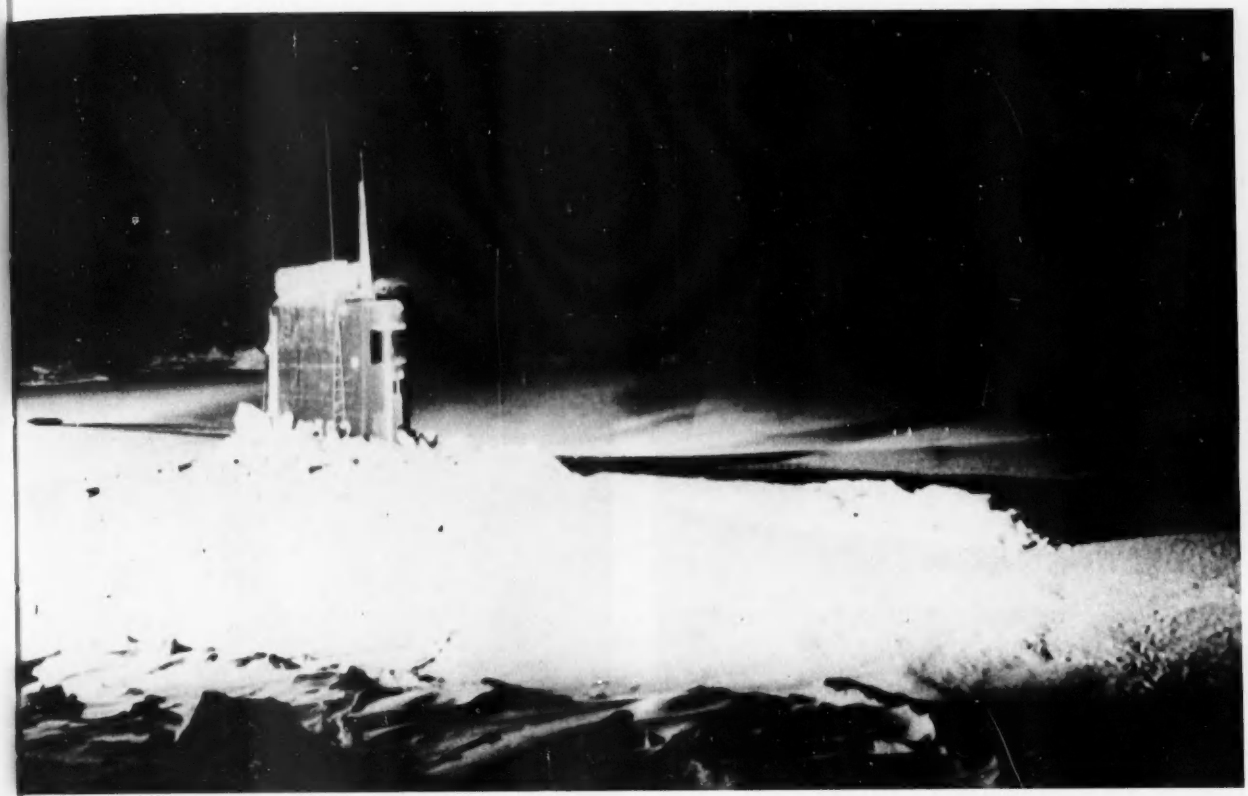
FIG. 9. Underwater observation through a glass window let into the hull of *Nautilus*. Jules Verne gave the dimension of this giant cephalopod as 8 m. long. From "Vingt Milles Lieues sous les Mers", 1870.

FIG. 10. The *Nautilus* caught in the pack ice at 67° 39′ S and 51° 30′ W of the Paris meridian. Further progress towards the South Pole was easily achieved by diving. From "Vingt Milles Lieues sous les Mers", 1870.

FIG. 11. Night at the North Pole. The U.S. nuclear submarine *Sargo* rests quietly in the Arctic ice on the top of the Earth. A photograph taken during February 1960.







THE *NAUTILUS*

The most accurate prediction of Jules Verne is no doubt the submarine. When his book "20,000 Leagues Under the Seas" appeared in 1870 only a few submarines had been built. Most of these were driven by hand, and few of their inventors had lived to tell their tale. The first power-driven submarine—which used compressed air—was constructed by Bourgeois and Brun in 1863 at Rochefort and Jules Verne may well have known its details. However, his *Nautilus* was far in advance of anything then remotely thought of by naval architects. Of cylindrical cross-section with conical ends, she was 70 m. (230 ft.) long and 8 m. (26 ft.) in diameter, with a displacement of 1500 tons. A double hull was used to contain the water ballast for trimming and diving and the water was ejected from these tanks by means of powerful pumps. Steering was done through normal hydroplanes and rudder. Air was compressed and carried in cylinders for the breathing of the crew and a watertight air-lock in the hull allowed divers to enter or leave the *Nautilus* while submerged. Great observation windows were fitted through which photographs of underwater life were taken. All services on board were electric: propulsion, cooking, water distillation, heating, underwater searchlights, and even the defence of the submarine against hostile intruders. Captain Nemo, the name assumed by the Indian prince Dakkar, employed his submarine for oceanographic research, and also to avenge his country against Great Britain by sinking her ships. His method of attack was simply to ram any British ship he could find.

Actually, submarines were not used for biological research until January 1959, when the Russian submarine *Severyanka* made a 4000-mile cruise to study herrings and herring fishing. She was equipped with a large variety of special scientific instruments to measure temperatures, salinity, dissolved hydrogen, and underwater currents. Apparently her propulsion unit was of standard diesel-electric nature.

However, the most accurate verification of any prophecy came with the nuclear-powered American submarine, the U.S.S. *Nautilus*. Exactly like her earlier namesake, all services on board were maintained by electricity, with the additional items of underwater television and a juke box. Her historic crossing under the North Pole on August 4, 1958, recalls immediately the similar exploit of Captain Nemo in his *Nautilus* at the South Pole: there Nemo found a steep rock emerging from the icy waters on which he planted his flag. Returning northwards, Nemo's *Nautilus* was caught below an upturned iceberg and could only free herself with the greatest difficulties. Cmdr. W. R. Anderson in the U.S.S. *Nautilus* found his greatest difficulty at the beginning of his cruise in the shallow waters north of the Bering Strait where his submarine was narrowly caught between the ice above and the sea floor below. Indeed, when Jules Verne wrote his tale eighty-eight years before the event, his scientific imagination had reached great heights.

TRAVEL INTO SPACE

In fact, there are few books of Jules Verne's which do not contain some remarkable extrapolations of the knowledge at his own time. In his second work, "Journey to the Centre of the Earth" published in 1864, he foretold in a most imaginative way the science of speleology. The two books which followed, "From the Earth to the Moon" 1865, and "A Trip round the Moon" 1870, showed for his days a spirit of scientific reality and detail of quite outstanding magnitude, although of course the basic principle of shooting a manned hollow shell from a giant gun to the Moon was wrong. Such a shell would be flattened to a thin disk between the two powerful pistons of the expanding charge and the air resistance in the gun barrel. Nevertheless, Jules Verne worked out accurately the escape velocity from Earth. In his book the then very rare element aluminium was used for construction of the shell, and trial shots were fired with animals. Verne envisaged a reflecting telescope of 192 inches (compare this with Mount Palomar's 200 inches), and sited his firing-point of the gun only 37 miles (60 km.) from Cape Canaveral in Florida with immense crowds watching the event. He invented the counting-down to zero. He discussed space-suits but rejected them; he described free fall, and used twenty retro-rockets to return the projectile to Earth. He found no life on the Moon. For a book published in 1870 this is very creditable.

Verne's masterful combination of his two piles of notes has yielded many other astonishing forecasts. The record achieved in the "Around the World in 80 Days" (which appeared in 1873) was handsomely beaten during his own lifetime. "The Begum's Five Hundred Millions" published in 1879, contained descriptions of poison gas and a giant cannon of 1·5 m. (5 ft.) diameter firing a shell a distance of 40 km. (25 miles); both were designed by a German, Herr Schultze, whose speeches were the exact prototypes of Herr Hitler's. In 1880 appeared the story "The Steam House" in which a caravan train crosses India, drawn by a steam engine disguised as an elephant. Nine years later in 1889 Verne published his only work in English, called "In the Year 2889"; in it he briefly mentions transatlantic television, interplanetary exploration, and rolling roads. Perhaps one should mention finally "Before the Flag" 1896; in it a French chemist of evil genius, Thomas Roch, perfects guided missiles and an explosive which destroys all life in a radius of 10 km. (6·5 miles). There is no end to his imagination: inflatable life-jackets with sails, journals of edible paper with chocolate printing-ink, milk and cream from whales, and telegraphic transmission of piano playing, as well as the prediction of the cinema and the artificial satellite, of skyscrapers and garden cities.

FIG. 12. Free fall in lunar rocket as imagined by Jules Verne. He thought that this condition occurred only at one point of the voyage from the Earth to the Moon, namely where the two gravitational fields were exactly equal and opposite. From "Autour de la Lune", 1870.

THE BASIS OF PREDICTION

How was it possible that Jules Verne could predict so accurately so many scientific developments? First, all visions of the future must be given enough time to mature and, provided that a peaceful exponential growth of science continues, many of today's apparently extreme forecasts of the future may be likewise fulfilled. Secondly, he was gifted with an extremely logical French mind, and great imagination. He saw small beginnings which he extrapolated courageously, like heavier-than-air aviation and the submarine. Once a trend was seen by him, and once he saw that its development was advantageous, he could, by sheer imagination, draw up the specification for the fulfilment of this trend. He saw that neither human muscle power, nor compressed air, nor steam power could lead to a satisfactory engine for a submarine; only electricity would provide the final answer, as indeed it did (it may here be immaterial whether generated by a diesel engine or an atomic reactor).

Similarly, once Verne had considered the question of aviation in full detail, he must have realised the scientific impossibility of using mere thermal expansion of the gas of a balloon to give it full manoeuvrability in the air, and

FIG. 13. Retro-rockets were employed to return to Earth from a satellite-orbit round the Moon by Jules Verne's space-travellers. This interesting fact is not generally known, as the launching of the rocket from Earth was carried out by firing it from a giant gun. From "Autour de la Lune", 1870.

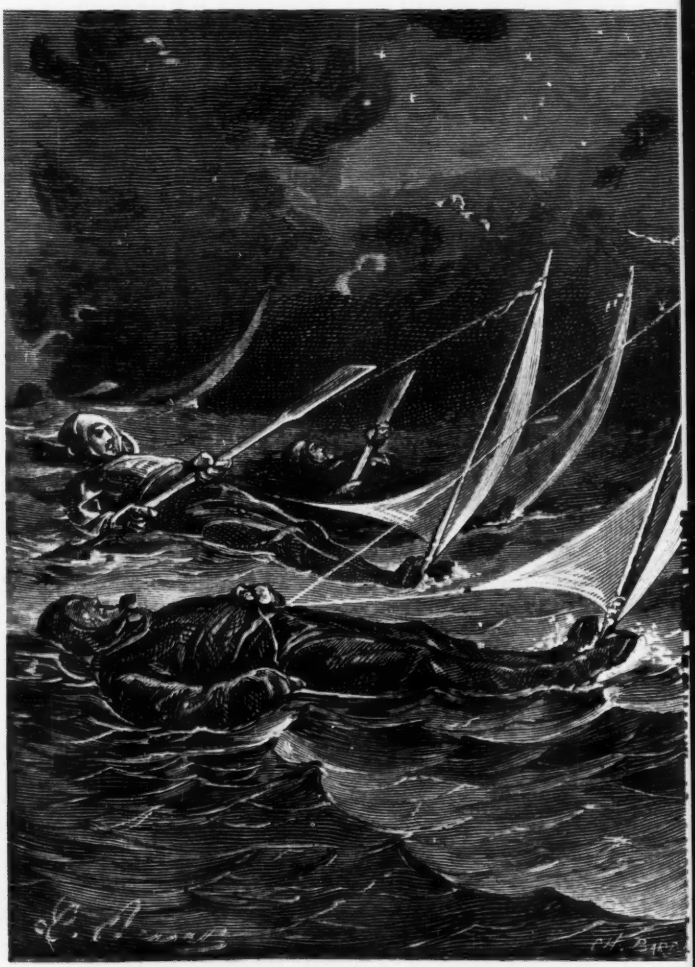


FIG. 14. Inflatable lifejackets, although known already when Jules Verne wrote this tale, were hardly more than a curiosity. (See DISCOVERY, 1960, vol. 21, No. 4, p. 154.) He merely added a sail for navigational purposes. From "Les Tribulations d'un Chinois en Chine", 1879.

(All the first editions of Jules Verne were published in the Collection Hetzel, Paris. The illustrations are taken from the author's private collection of these splendid volumes.)

without that, proper aviation does not exist. The only alternative is a power-propelled and power-sustained aircraft.

A helicopter had been found theoretically feasible and appeared to him perfectly logical, as indeed it proved to be in due course. Incidentally, a triphibious craft has not been designed since 1904, simply because there is no apparent need for it; should it prove necessary, modern materials and sources of power would no doubt be able to solve the inherent difficulties.

It may be objected that it is easy to pick out examples of successful predictions after the event. Nevertheless, it is possible to make rational predictions with a fair expectation of success. It appears extremely unlikely that space-travel proper can be undertaken with chemical rocket fuels alone, as even now, they have almost reached the theoretical limits of their performance. The only real alternative appears to lie in nuclear rockets. Also, the problem of congested city traffic may very conceivably be solved by rolling roads, just as the conveyor-belt did solve the problem of mass production. Both nuclear rockets and rolling roads have been widely described by science fiction writers.

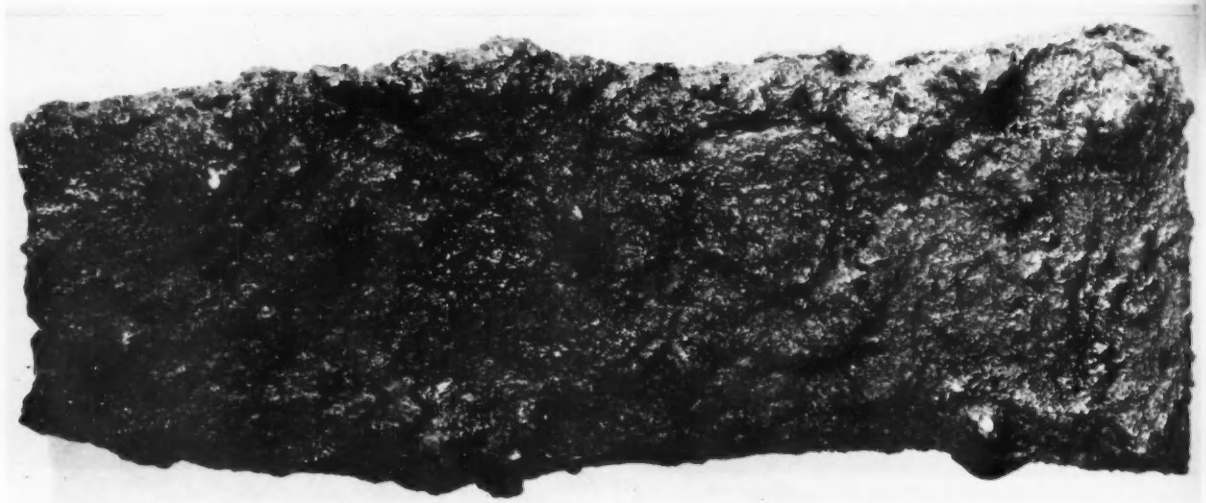
Man still longs to know the future, perhaps more than ever today. Provided severe logic and great imagination is used, there is no real reason why extrapolation of present trends may not yield accurate forecasts. Many have surpassed Jules Vene in the scale of their stories' backcloth, but none has succeeded in combining recreation and education in his unique manner. It has remained the envy of all.

THE DISCOVERY AND TREATMENT OF AN INLAID SCABBARD

KENNETH JAMES BARTON

Assistant Curator in charge of Conservation, The City Museum, Bristol

Towards the end of 1897 a quantity of Roman military objects were found in the course of excavations at Waddon Hill, Bridport, Dorset. Some of these objects were given to Bridport Museum. Recently they were found to be in a serious state of deterioration, and as they had never undergone any preservative treatment the Bridport Town Council arranged for them to be treated by the writer in the laboratory of the City Museum, Bristol.



The iron objects were all in an advanced state of corrosion and included one roughly in the shape of a Roman dagger scabbard (Fig. 1). It consisted of a thin sheet of iron, with a slight curve on the long edges, to one side of which appeared to be adhered the fragments of the other part of the scabbard. The whole was covered with a thick and continuous film of iron corrosion products. On the front face the presence of several rivets was suggested by larger lumps at each side.

An x-ray photograph (Fig. 2) showed that the surviving side contained a fine inlay in some metal other than iron and five rivets in a different metal. The serious condition of the object could be judged by the presence of several major cracks that occurred throughout the length and width and also the presence of a mosaic of minor fractures near the surfaces. However, as it is known that this form of scabbard decoration is rare in this country it was decided to attempt to expose it despite its fragile condition. The problem of retaining the structure in its complete form while removing the corrosion products overlying the inlay was overcome by filling in the back of the remaining whole side of the scabbard with a cement consisting of Perspex and fibreglass. Before applying the cement, the back was carefully scoured with a wire brush to ensure a firm bond. The scoured surface was then primed with an ethylene dichloride-Perspex solution, and the cement poured into a mould formed by building up the sides with Plasticine.

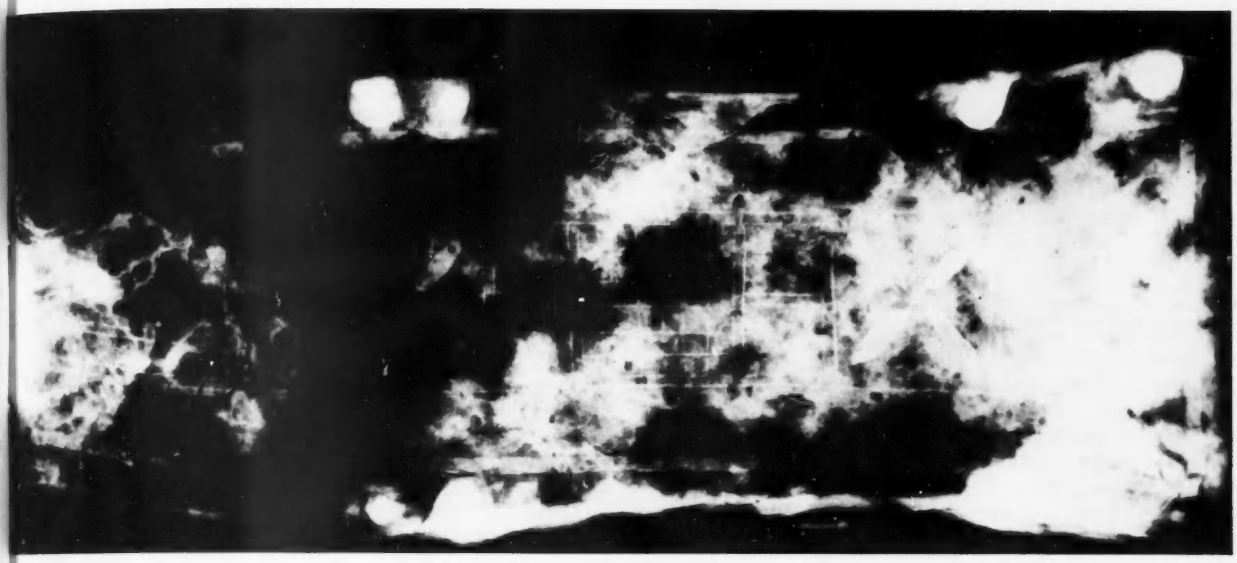
When the object was consolidated, the surface corrosion was removed by grinding. This was effected with a coarse quality dental grindstone, powered by a dental drilling machine. When the excess corrosion had been removed down to the body, which was indicated by a change in colour and texture, the final layers immediately over and around the inlay were removed with a fine quality grindstone. The revealed inlay and body were burnished with a hard felt wheel charged with jewellers' rouge (Fig. 3). A small fragment of the inlay was spectrographically examined, and shown to be mainly of bronze with some gold present. The presence of gold may perhaps indicate gilding of the inlay.

The scabbard was then given a series of washes in hot distilled water until its condition was stabilised, then dried by water transference in ethylalcohol, reburnished and coated with Resin MS2 picture varnish.

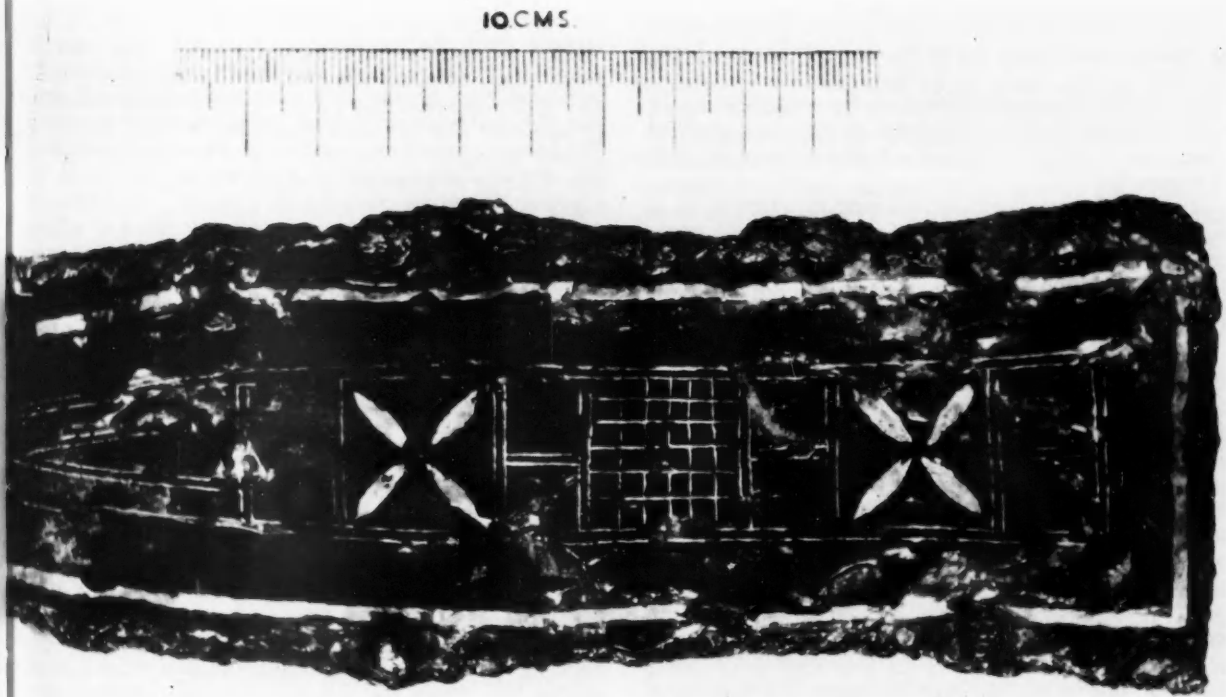
The scabbard will shortly be exhibited in the newly designed display at the Bridport Museum.

(*This is an extract of a paper published in the* Museums Journal, *February 1960.*

The writer wishes to acknowledge the co-operation of the Works dept, Bristol Aircraft Co. in providing facilities.)



The three photographs show first FIG. 1 (*left*), the iron object before treatment; FIG. 2 (*above*), the X-ray photograph showing details of the inlay on the scabbard; and FIG. 3 (*bottom*), the scabbard after treatment and as it will now be preserved.



SCIENCE VERSUS BABEL

J. JACKSON

The problem of communication between scientists of different nationalities is becoming acute. Attempts to overcome the language barrier include translating machines, synthetic languages, and special courses in technical translation.

One of the proudest claims made for science is that it is international in character. Yet communication between scientists of different nationalities, so vital to the progress of science, is hampered by the language barriers that exist amongst them. There is no doubt that scientists are, on the whole, more familiar with scientific papers and books in their own language than they are with publications in other languages, and to this extent science is not truly international and the progress of science is slowed down. The problem of language barriers in the sciences has come much to the fore in recent years with the rise to prominence of Soviet science and hence the increasing importance of scientific publications in Russian, but it has existed ever since Latin ceased to be the international language of learning. At the present time, the best estimate is that at least 50% of scientific literature is in languages which more than half the world's scientists cannot read.

Anything which can be done to reduce language difficulties in science is clearly of the greatest importance. There are three ways in which this can be done.

(1) Increasing the amount of scientific translation, either by human translators, or with the aid of translating machines.

(2) The use of an international auxiliary language, which could be either an existing language, perhaps in a modified form, such as Basic English, or a synthetic language, such as Esperanto.

(3) Improving the language teaching of scientists so as to increase the number capable of reading scientific literature in languages other than their own, and thus reduce the need for translation.

DISADVANTAGES OF TRANSLATION

Translation is perhaps the most obvious method of overcoming language difficulties, and is being used more and more widely. The emphasis is now very much on the translation of Russian scientific publications: an entirely new feature is the production, both in the United States and in this country, of complete cover-to-cover translations of Russian journals into English. It appears that no less than 55 such journals are being translated in this way, and that the translation of a further 21 is envisaged in this country alone. By the time this statement appears in print it will almost certainly be out of date, since new translations are continually being announced. Even so, this represents no more than a small fraction of the total number of Soviet scientific and technical journals which are published, though many, of course, are not worth translating. Furthermore, no steps seem to have been taken so far to translate journals published in other European languages, to say nothing of Chinese and Japanese. There remain, in addition, the scientific and technical books, large numbers of which again are published every year in Russian. (Some 456 titles amounting to 109,000 pages came from one Soviet publishing house in 1958.) These are much more difficult to deal with in any organised fashion, yet they could be extremely valuable in providing an introduction to the Soviet literature on a particular subject. The difficulty with many of the Russian books is that they are so highly specialised that it would be uneconomic to publish a translation in the ordinary way in this country. It has sometimes been possible, however, for a number of organisations interested in a Russian book of this kind to combine to sponsor its translation and thus to share the cost, which would have been too great for any one of them to bear alone.

The disadvantages of translation are that it takes time, so that there is an inevitable delay before the translated material is made available to scientists who cannot read it in the original, and that the cost of a translated journal for example, may be considerably greater than that of the original. With the increasing demand for translations it seems quite likely that a shortage of suitably qualified translators might develop, if it has not done so already, and that the quality of translation might consequently suffer. The exacting requirements called for in scientific translating are not generally realised. Contrary to what might be expected, the prime requirement is not a high degree of competence in the language concerned, but rather an expert knowledge of the subject-matter of the material to be translated. Without a knowledge of the correct scientific terminology, which can only be possessed by an expert, a translator might well produce a result which would be unintelligible to the reader; the possibility of his doing so increases with the degree of specialisation of the subject. Apart from technical and linguistic attainments, a good translator must also have the ability to express himself clearly in his own language. It is obvious that translators possessing all these characteristics must be relatively rare.

We might perhaps hope to increase the number of scientific translators by making the work financially more attractive. At present there is no doubt that the difficulties of translation are underestimated and translators undervalued. On the other hand, the development of electronic computors as translating machines opens up the possibility of at least reducing the need for human translators. It is not easy to be certain how much real progress has been made in the development of machine translation. Apart from a relatively small amount of work in this country, the effort has been

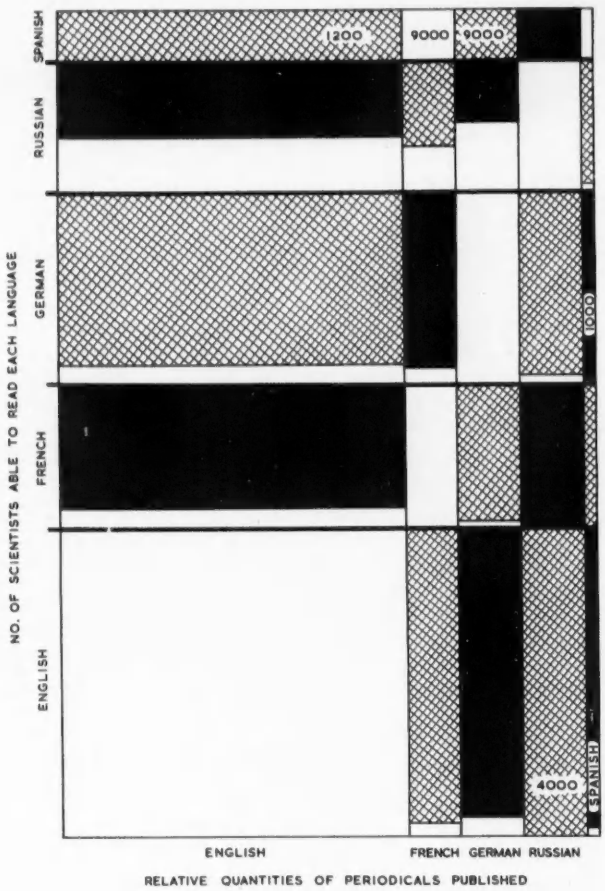


FIG. 1. The diagram is divided into vertical strips, the widths of which are proportional to the amounts of scientific literature published in the five most important languages for science: English, French, German, Russian, and Spanish. The diagram is also divided horizontally according to the proportions of the total number of scientists in the world having these languages as their mother-tongues. Thus the diagram is divided up into a number of large horizontal rectangles; each of these may then be further divided horizontally into sections according to the number of scientists who can or cannot read the language concerned. Unshaded sections indicate ability to read, shaded and black sections the opposite. For example, all English-speaking scientists can read English, so that this particular rectangle will be completely white. On the other hand, only a few French-speaking scientists can read German, so this rectangle must contain a shaded area. The shaded and black areas in the diagram thus indicate the degree of mutual incomprehensibility that exists between the scientists of the world. The diagram is based on the data given in the UNESCO publication "Scientific and Technical Translation", Paris, 1957, and is intended to show orders of magnitude only.

concentrated mainly in the United States and the Soviet Union. In the United States, the first technical journal in the world devoted to machine translation started publication in 1954 and the first book on the subject was published in 1955. Reports have since appeared of a research project at the University of California, which, it is claimed, will cut the cost of Russian translation by half. In the Soviet Union, work started in 1955 at the Institute of Precision Mechanics and Calculation Technique, and at the Steklov Mathematical Institute. Other organisations have subsequently joined in, and a technical journal on machine translation has been produced since 1958. The Russians seem to be covering a very wide field, since they have been translating Oriental as well as European languages into Russian.*

In its original form, the method used in machine translation was very much like that which might be adopted by someone who set out to read a text in a foreign language of which he was completely ignorant, that is, each individual word was "looked up" in a "dictionary" provided by the "Memory unit" of the computor, which stored the foreign words and their translations. As an improvement on this technique, the foreign words were split up into stems (not necessarily corresponding to the grammatical stems) and endings, or inflections. Stems and endings were then looked up in separate stem and ending dictionaries, the endings providing certain grammatical information in addition to the "meaning" of the word derived from the stem. Even this more refined procedure gave results which were sometimes barely intelligible, if at all. Further refinements have since been introduced to enable the machine to take into account, not only the given word itself, but also those on either side of it. The Russians claim, that with this kind of technique, they successfully translated a French mathematical text into Russian as long ago as June, 1956. However, the subject-matter was highly specialised, and the vocabulary used was restricted to 1200 words and 250 idioms.

Among the difficulties involved in machine translation is that, so far, all the procedures are based on the assumption that there can be a one-to-one correspondence between words and phrases in two different languages. In fact, such a correspondence can never exist, not even, for example, between two such simple words as *cat* and *chat*; the two words must inevitably call up different associations in the minds of Englishmen and Frenchmen respectively. Difficulties of this kind are perhaps more important in the translation of literary works than in science. More important is the problem of multiple meanings—the problem which arises when a given word in one language can have several possible meanings in another. Satisfactory methods of dealing with the ambiguity which can then result do not yet seem to have been devised.

* A new book entitled "An Introduction to Machine Translation" by E. Delavenay was published by Thames & Hudson at the end of May.

FIG. 2. A typical example of modern practice. On the left is an English translation of the Russian original journal shown on the right.

INTERNATIONAL LANGUAGE

A far thornier subject to deal with than that of translation, either human or machine, is the reduction of language difficulties by the use of some suitable international auxiliary language (the emphasis is on the word auxiliary: there is no suggestion that national languages should be superseded). It has been suggested that, because of the combined scientific and industrial weight of Great Britain and the United States, English is well on the way to becoming such a language. I might add that this process is also favoured by the well-known reluctance of English-speaking people to learn foreign languages. There is certainly some truth in this suggestion. Some of the smaller European countries, for example, already publish a certain amount of their scientific material in English, and English is also used by some Asian countries, such as India. Yet it seems unrealistic to me to suppose, with the world in its present state, that the process could ever go far to solve the language problem in its entirety, to say nothing of the vast areas of the world in which Russian and Chinese are the dominant languages, and where the use of English seems extremely unlikely. This is an era of nationalism, and the boosting of the national language is one of the easiest ways in which nationality can be asserted, even if this is at the cost of intelligibility. In my opinion, the language problem is going to get worse, not better, as more and more countries become active in scientific research.

It is because passions are so easily aroused by language questions that, at least in part, the synthetic languages have their advocates. There can be no objections on grounds of national feelings to a synthetic language, as there can be even to a modified form of a national language, such as Basic English. Moreover, a synthetic language can be designed from first principles, and so should be easier to learn and to use than any natural language which has grown and so is full of grammatical complexities and irregularities. Experiments have shown that secondary school children found Esperanto easier to learn than French.

Some 300 schemes for synthetic languages have been put forward since Descartes first considered the possibility of of such a language in 1629, and new languages are still being developed. The fact that so many schemes have been proposed and that new proposals are still coming forward, does seem to show that no truly satisfactory solution to the problem has so far been found. The two synthetic international auxiliary languages most in prominence at the present time are Esperanto and Interlingua. A certain amount of scientific material is being published in Esperanto. It seems to be particularly popular in Japan, where six scientific journals occasionally carry articles in Esperanto, as do also seven other scientific journals in other parts of the world. It appears that Interlingua is used mainly in abstract and other scientific bulletins published in the United States. It seems to me that the synthetic auxiliaries inevitably encounter two serious difficulties, one theoretical and the other practical. In order to make a synthetic language easy to learn, it must approximate as closely as possible in vocabulary to some suitable group of natural languages. Because synthetic languages have so far been devised by Europeans, the existing synthetics are closest to the natural European languages. Unfortunately, this must make them correspondingly more difficult to learn by speakers of non-European languages. Thus the ease with which Interlingua can be read by Western Europeans is not so advantageous as it may appear, and tends to disguise the fact that it must be as unintelligible to non-Europeans as any other European language. Only Lancelot Hogben, in his synthetic language called Interglossa, has attempted to solve this problem by taking for his vocabulary those Greek and Latin roots which are already internationally known and used in scientific and technical terminology throughout the world. He combined

FIG. 3. A page from Chapter VIII, Class VI. The Verboids of Lancelot Hogben's "Interglossa", Penguin Books, 1943.

reacte recipro = *respond to one another; click* (10)
reacte petitio Y = *comply* (with a request of) *Y* (41)
reacte questio Y = *answer* (a question of) *Y* (42)
reacte tacto Y = *feel Y* (124)
reacte volo Y = *conform to the wishes of Y* (128)
reacte archo Y = *submit to Y* (153)
reacte baro Y = *respond to the pressure of Y* (157)
reacte batho = *be geotropic; be geotactic* (159)
no reacte chromo = *be colour blind* (174)
reacte claustro = *have claustrophobia* (175)
reacte comico Y = *see the joke in Y* (180)
reacte controlo Y = *submit to* (the discipline or guidance of) *Y* (185)
reacte critico Y = *heed the criticism of Y* (188)
reacte decoro (Y) = *appreciate the beauty* (of Y) (196)
reacte duco Y = *follow Y* (as leader) (207)
reacte major dyno (Y) = *capitulate* (to Y); *surrender* (to Y) (208)
reacte fisco = *pay one's taxes* (230)
reacte flavoro Y = *taste Y* (234)
reacte frigo = *be sensitive to cold* (240)
reacte grapho Y = *answer* (the letter of) *Y* (250)
reacte hydro = *react to water* (263)
reacte impacto Y = *recoil from Y* (265)
reacte impero Y = *obey Y, comply with the orders of Y* (266)
no reacte impero Y = *disobey Y* (266)
reacte lego = *be law-abiding* (280)
reacte musico = *appreciate music* (313)
reacte occasio Y = *seize an opportunity of Y* (328)
reacte odoro Y = *smell Y* (329)
reacte offero Y = *accept Y* (330)
reacte pecunio Y = *acknowledge the payment of Y* (348)
reacte photo = *be sensitive to light* (359)
reacte phreno = *be rational* (= respond to reason) (360)
reacte profito = *be corruptible; be venal* (374)
reacte protesto = *take notice of a complaint* (378)
reacte pyro = *be combustible* (384)
reacte saluto Y = *acknowledge the salute* (or *greeting*) *of Y* (404)
reacte scholo Y = *pay attention to the teaching of Y* (409)
reacte tensio = *stretch* (intr.); *be elastic* (434)
reacte thermo = *be heat-sensitive* (437)
reacte vlolo Y = *withstand Y, put up a fight against Y* (455)
reacte viro Y = *be wary of Y* (456)

(479) **stimule,** *evoke; excite; stimulate; influence;* (adj.) *stimulating; inspiring; exciting*

no-stimule = *boring; boredom;* (*dull*)

The general formula for operative couplets of **stimule** with an amplifier (A) is: *X evokes the response A from Y;* or if

la elektrodoj de la efluva lampo (en la fig. ne desegnita). Ni esploras nun unuopajn frekvencojn de la hidrarga lampo enmetante lumfiltrilon en la lumgarbon (en la bildo desegnita antaŭ la lenso). Se mi konektas la antaŭe determinitan flamigan tension al la efluva lampo, vi vidas la ekflamon. Se mi iomete malpliigas tiun tension, vi vidas ke la lampo ne ekflamas. Sed se mi faligas sur ĝin la radiaĵon de la hidrarga lampo, vi konstatas ekflamon. La samon vi konstatas, se mi faligas sur la lampon tra viola, respektive blua filtrilo nur la radiaĵon kun la frekvenco 7,41, respektive 6,88 × 10^{14}. Sed se mi faligas sur la efluvan lampon tra verda, respektive flava filtrilo radiaĵon kun la frekvenco 5,49, respektive 5,19 × 10^{14}, vi konstatas, ke la lampo ne ekflamas. Nun ekstaras la demando:

Ĉu eble la distribuo de energio en la hidrarga lampo estas tia, ke la energio elsendata po sekundo, la *potenco,* estas en la viola kaj blua radiaĵoj pli granda ol en la verda kaj flava? Tiamaniere la viola kaj blua radiaĵoj povus elŝiri elektronon el la metalo, alivorte: komuniki al la elektrono tiom da energio, ke ĝi povas forlasi la metalon luktante kontraŭ ĝiaj altiraj fortoj kaj poste flugi libere kun restanta kinetika energio transdonita per la radiaĵo.

Por solvi tiun demandon mi anstataŭigas la efluvan lampon per tre sentema termometro, kies varmiĝo informas nin pri la potenco de la radiado sur ĝian areunuon. Kiel termometron mi uzas termoelektran baterion (en fig. 4 sur la optika stablo dekstre) konektitan kun galvanometro, kies devio indikas al mi la temperaturon kaj per tio la potencon po areunuo de la koncerna radiado. Per tia mezurado mi konstatas, ke la lumo-elektre aktivaj, la viola kaj blua radiadoj, havas

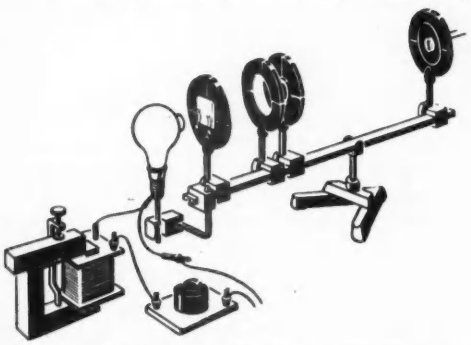


Fig. 4. La diversaj frekvencoj de la Hg-lampo estas esplorataj per termoelektra baterio (ĉe la dekstra ekstremajo) pri sia potenco.

FIG. 4. A page from an article by Prof. D-ro Hugo Sirk, entitled "Ĉu Ekzistas Atomoj de Energio?" published in *Scienca Revuo*, 1959, vol. 11-a, N-ro 2-a (42-a), an Esperanto Science Journal.

SCIENCE. A branch of study which is concerned with a connected body of demonstrated truths or with observed facts systematically classified and more or less colligated by being brought under general laws, and which includes trustworthy methods for the discovery of new truth within its own domain.

INTERGLOSSA

Scientia eque geno scholo su habe curo allo de ge zygo fascio de plu verito ge demonstro allo de ge scopo data ge systemo plus harmono holo allo mero per universo nomo. Syn re, scientia habe in auto plu methodo valo de credo tendo detecte neo verito in auto thema.

INTERLINGUA

Scientia (scir—sciente—scientia). Un branca de studio, que es concernite con un connectite corpore de demonstrate veritates o con observate factos classificate systematicamente interligate plus o minus nettemente sub le dominio de leges general, e que include valide methodos pro le discoperta de nove veritates intra le limites de su interesse.

ESPERANTO

Fako de studo pri aro da demonstritaj veroj au observita faktaro, sisteme klasita kaj pli-malpli koneksa lau generalaj legoj, kiu tidindrimede provizas por la eltrovo de nova vero en sia propra tero.

the use of these roots with that of a grammar, or rather an absence of grammar, resembling that of Chinese. It is unfortunate that this scheme has had so little support and that the ideas on which it is based have not been taken up.

Perhaps more important than such theoretical objections is the fact that the universal acceptance of any synthetic language would seem practically impossible to achieve. Linguists cannot agree among themselves as to the choice of such a language, so that the possibility of obtaining the agreement of governments to give any one language the backing which is necessary if it is to be accepted seems remote indeed.

SPECIAL COURSES FOR SCIENTISTS

There remains the possibility that more scientists could be encouraged to learn foreign languages. This would be valuable even if they only acquired sufficient knowledge to enable them to decide whether a scientific paper, or part of it, was worth translating by a professional translator, since much valuable translating time could thereby be saved. Fortunately, the task of acquiring linguistic knowledge of this character is not nearly so difficult as that of learning to speak or write a foreign language, or even to read literary classics in it. Moreover, the scientist will be greatly helped in his task by his familiarity with the subject-matter of the material he is trying to read. Too many scientists, no doubt, have been put off learning languages by conventional courses and equally conventional textbooks designed to teach the literary language, and not in the least tailored to meet their own specialised needs. It is good to see, therefore, that a German language textbook specifically intended for use by chemists wishing only to be able to translate German chemical literature is now available. Similar textbooks should be produced as quickly as possible for other sciences and other languages of interest to scientists.

The need for increased linguistic knowledge by scientists is shown by figures such as those recently published for the United States, from which it appears that only about 2% of American scientists know Russian (the proportion of scientists in Great Britain with a knowledge of Russian is believed to be roughly the same). This need will remain, even if cover-to-cover translations of foreign journals were to extend over a much wider field than they seem likely to at present, since a vast mass of literature in the original language published before these translations were produced will still be left. Many scientific and technical books will also, no doubt, remain untranslated.

According to the Annual Report for 1958 of the Advisory Council on Scientific Policy, some form of Russian course for scientists is available at more than half the universities in Great Britain, though attendances are often very small. More encouraging, perhaps, is the fact that Russian courses are in progress, for example, at Rothamsted Experimental Station, and within the Ministry of Supply. In the United States, a number of industrial concerns are either organising Russian courses themselves, or are combining to sponsor them at nearby educational institutions. There is obviously room for a great expansion of these special courses, designed specifically to meet the needs of scientists, and it is to be hoped that industry will be sufficiently enlightened, both to help to arrange such courses, and to encourage scientific and technical staff to attend them. Courses are needed, naturally enough, not only for Russian, but also for all other languages of importance to science. If a sufficient number of scientists can be induced to acquire a reading knowledge of these languages, science will be well on its way to winning its battle with Babel.

GEOPHYSICS AND SPACE RESEARCH

By ANGELA CROOME

Zodiacal Light Photographed

What is the zodiacal light? This has been a puzzle since the 17th century when the curious cone of light extending out towards the zodiac that is visible at certain seasons and certain latitudes in the late evening and early morning sky first came to be scrutinised. Seen from the Earth the cone lies in the plane of the ecliptic; that is, it extends point upwards almost vertically from the horizon in equatorial regions.

It is because of this that it has long been associated with the Sun. It is now understood to be due to the scattering of sunlight from particles in interplanetary space. This extremely tenuous material—several orders of magnitude more sparse than in the best laboratory vacuum attainable—has two components, dust and the electrons of the interplanetary gas. But what are the proportions of the one to the other? This is a matter of the greatest significance to astrophysicists. The electrons can only be part of the Sun's "atmosphere", the outer regions of the solar corona, and this is little understood and extremely hard to measure. The photography of the zodiacal light offers a means of measuring the electron density of the corona far out, between 50 solar radio and one astronomical unit.

D. E. Blackwell and M. F. Ingham of the Cambridge Observatories succeeded during the period June to August 1958 in doing this from Chacaltaya high-altitude station in Bolivia. The latitude of the station (close to the Equator) and the great altitude of the site (17,100 ft.), which places it above the distorting layers of the atmosphere, enabled them to observe the zodiacal light in optimum conditions. Seen from Chacaltaya it compares in brightness to a quiet *aurora*—as may be seen from the picture, though this is slightly over-exposed for the purposes of the experiment.

From a spectral analysis of the zodiacal light compared with the solar spectrum, a value for the electron density in the outer corona can be derived. This method depends on the argument that the two spectra would be identical if only dust were present to cause the sunlight scattering that produces the zodiacal light phenomenon seen from the Earth. Preliminary analysis of the expedition's results suggests that there is an electron component but that this is much smaller than has hitherto been suggested and generally agreed. The value of 10^3 electrons/c.c. at one astronomical unit (the distance of the Earth from the Sun) appears to be excessive and Blackwell and Ingham's findings agree better with the 250 electrons/c.c. derived from recent work on "whistler" atmospherics (see DISCOVERY, 1957, vol. 18, No. 9, p. 398). The final results of the Chacaltaya expedition are expected shortly. This expedition has, incidentally, produced the finest photograph of the zodiacal light yet obtained.

Photograph of the zodiacal light taken from Chacaltaya, Bolivia (17,000 ft.) when the Sun was 18° below the horizon, by D. E. Blackwell and M. F. Ingham. A single lens and camera was used (aperture $f/1{\cdot}8$, focal length 5 in.) with an exposure of ten minutes, which accounts for the star tracks on this plate.

(By courtesy of D. E. Blackwell and the Cambridge Observatories)

Polar Orbit for Canadian Satellite

Thirty-foot-long radio aerials that will uncoil after launching, like a carpenter's steel rule, will be carried by the artificial Earth satellite now being designed by the Canadians. An official announcement about the project was recently made in Canada. This satellite is expected to be the first to convey British instruments into orbit since its scheduled launching, autumn 1961, will probably somewhat pre-date that of *Scout I*, the U.K.-U.S. research satellite.

The Canadian space package like that of the United Kingdom is being launched by courtesy of NASA, and the rocket that puts it into a near-polar orbit from Vandenberg Field, California, will be an American *Thor-Delta* (a three-stage vehicle). But, in contrast to the British, the Canadians are building the satellite shell as well as the instruments to go inside it. The Canadian Defence Research Telecommunications Establishment, Ottawa, is responsible both for the construction of the shell and the development of the instrumentation.

A fine Russian photograph of the *aurora*. This characteristic form is known as "draperies" or "curtains". Both *Pioneer V* and the projected Canadian satellite are relevant to auroral studies.

The satellite shell is to be of aluminium and fibreglass, nearly spherical with a 42-in. diameter studded all round its "equator" with solar cells. Its total weight with instruments will be, like *Scout I*, about 200 lb. Four complete packages are being built; one for ground-testing the equipment, one for the prototype satellite and two "standbys".

The two experiments to be carried are both relevant to long-range telecommunications which in turn are a pre-occupation of defence planners. (The satellite has gained its priority through its status as fundamentally a defence project.) The two 30-ft. radio aerials will be carried to observe radio noise from the galaxy. This information is needed by both Canada and the U.S. to improve long-distance radio communications. This "galactic noise" is of comparatively long wavelength which cannot penetrate to instruments on the ground. A similar experiment is understood to be scheduled for inclusion in the second U.K. satellite package, *Scout II*, expected to be launched in 1962 (see DISCOVERY, 1960, vol. 21, No. 3, p. 123).

The other experiment in the Canadian satellite is the so-called "topside sounder". This uses the familiar technique of vertically sounding the ionosphere by directing a sequence of pulses at it to determine height and electron density—only here it will be probed from above instead of below. By comparing the height of the bottom of the ionosphere obtained from ground measurements with the height of its top from the satellite data the thickness of the ionised region will be revealed. The comparatively long lifetime of the satellite will enable the variations of the ionosphere with time to be studied. As the satellite will travel in a semi-polar orbit these measurements will also give information on the influence of the *auora* on the ionosphere. All this information will be invaluable for the better understanding of the factors that affect long-distance radio links.

Four tracking-stations will be set up in Canada and operated by the Canadians. The U.S. will be responsible for a number of others elsewhere. Data are to be exchanged through the COSPAR network.

Antarctic Perspective

If anything Antarctic weather and ice conditions this season have been worse even than last. Consequently expedition reports on the whole tell of frustration and delay —ships beset, aircraft and installations damaged, plans upset or postponed.

The **Australians** have suffered the worst. The run of bad luck that began the previous year, when two exceptional storms and a bad fire which between them destroyed irreplaceable scientific records and valuable equipment, has persisted into this season. In May 1959 a member of the Mawson team suffered a nervous breakdown but could not be brought home until the early Antarctic spring, several months later, when an aircraft could be flown in to evacuate him. During January the principal relief ship, the *Magga Dan*, became jammed in the ice and holed by a floe. At about the same time the two Beaver aircraft at Mawson were wrecked during a violent storm. During a survey flight near Hatch Island in February one of the two helicopters which were being tried out this season ran into considerable turbulence and crashed. There was no loss of life, and by then helicopters had already more than proved themselves.

Despite these set-backs the principal objects of this season's programme were achieved. The Wilkes station (which the Australians have taken over from the Americans) was successfully relieved in February. The relief ship was then able to penetrate into Vincennes Bay and survey it for the first time as ice conditions proved unexpectedly easy. A landing was made near Hatch Island. Farther east the Australians made the first known landing on Davis Island despite extremely awkward ice and tide conditions. A landing was also effected on the Sabrina Coast just west of Cape Southward.

A 350-mile dog-sledge survey was initiated in Enderby Land in March. The three-man team was landed from the *Thala Dan*, which afterwards proceeded westward and established a depot for the party at Kloa Point. After the inland exploration the team expects to travel eastward in Kemp Land to wait there until the sea freezes over securely and then sledge across it to Mawson.

In March the Royal Geographical Society announced the award of the Founder's Medal for 1960 to Mr P. G. Law, leader of ANARE, for Antarctic research and exploration. *Thala Dan* docked at Melbourne at the end of March with the returning Mawson team aboard —and the first case of a virus infection recorded from the Antarctic, that of an RAAF officer who contracted a mild form of poliomyelitis while serving at Mawson.

For this year's ambitious **Falkland Islands Dependencies Survey's** programme, Sir Vivian Fuchs personally led the expedition aboard the Danish charter vessel *Kista Dan*. Unhappily ice conditions off the Graham Land peninsula proved this season quite as bad as last year when the Stonington Island base had to be evacuated as the relief ship could not get into Marguerite Bay. The plan this season was to reopen the base and to land there the newly formed RAF party with its two aircraft which would enable air-supported surveys to be carried out far to the South where the terrain is virtually unmapped. This part of the programme has had to be postponed since *Kista Dan* was unable to get into Marguerite Bay again even after persistent attempts to force an entry through both northern and southern channels. The relief of the Horseshoe Island base off the coast in the north of the Bay was successfully carried out by air using the Otter in dangerous conditions. Four men were put ashore on Horseshoe Island with the idea of sledging down to Stonington in the winter when the sea-ice is firm. The other Marguerite Bay party, that intended to open a base on Adelaide Island which half blocks the northern entrance, were landed at the Argentine Islands base 200 miles or more to the north and will be flown into Adelaide Island in the spring. During its efforts to get through in the Marguerite Bay area, *Kista Dan* became stuck for fifteen days and was seriously threatened by pressure ice. The Argentine ice-breaker

General San Martin was also beset a few miles away and asked the Americans for help from their large icebreaker *Glacier*. *Glacier* reached the area during the first week of March and both British and Argentine ships got clear. Shortly after, the *Beaver* aircraft aboard *Kista Dan* had a wing torn off during a storm.

Other FIDS activities this season went off fairly smoothly and the *John Biscoe* successfully penetrated the Weddell Sea and relieved Halley Bay. The Beaver and Otter aircraft with the RAF party are overwintering at Deception. A runway was built during the past season out of volcanic ash at Deception Island—only the second non-ice runway in the Antarctic. The site is the same as that used by Sir Hubert Wilkins in 1928–9.

The **South Africans** eventually succeeded in getting the chartered *Polar Bjorn* to the coast of Queen Maud land where they have now taken over the station from the Norwegians. They had chartered the United Kingdom's *RRS Shackleton* for the relief of their stations on the Sub-Antarctic Islands.

The **New Zealanders** have completed a very considerable amount of surveying in Queen Victoria Land, though they lost a man and two others were injured when a Snocat plunged into a crevasse near their newly established camp at Cape Selbourne. Between November and February 1800 miles were mapped east and south of the Beardmore Glacier and a dozen peaks over 4000 ft. climbed by six members of the New Zealand Alpine Club. Specimens of insects discovered on lichen-covered rocks in the vicinity have been brought back to New Zealand for examination.

The Americans on the whole have had the most effective season. They succeeded in carrying out the important 1200-mile traverse in Marie Byrd Land despite a nine-day blizzard in early January. They spent from November 4 to February 8 in the field. They located a previously unknown ice-shelf on the coast, proved that Antarctica's highest mountain, Mt Vinson, 20,013 ft., does not exist and detected a deep sub-glacial valley between two newly discovered mountain ranges.

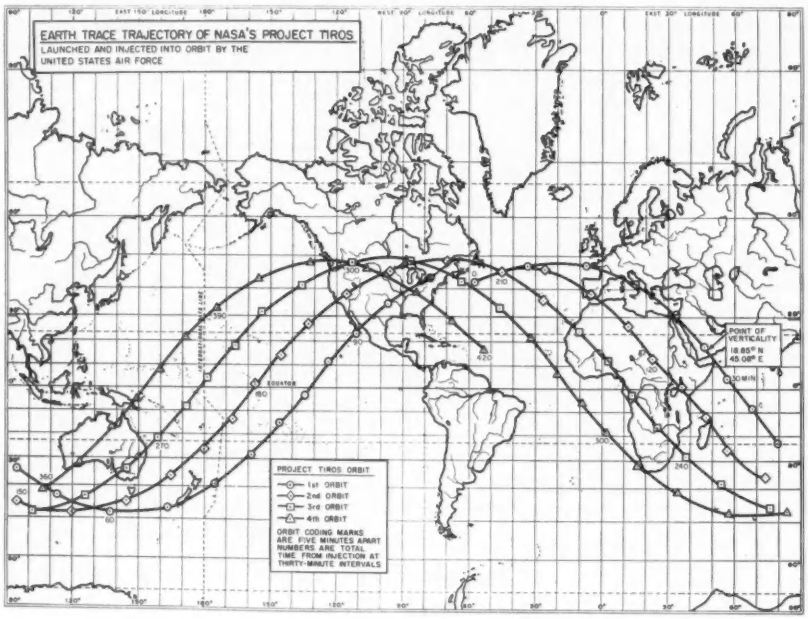
In February the U.S. icebreakers *Glacier* and *Burton Island* proceeding in company, succeeded according to plan in making the deepest penetration into the inaccessible Amundsen Sea at the root of the Graham Land peninsula. Bellingshausen in 1821 reached 69° 52′ S in this area, and the *Belgica* at the end of the century equalled this. *Glacier* has now achieved 71° S at 104° E longitude. A "grasshopper" automatic weather transmitting device was put ashore from the ships on Cape Flying Fish on the Thurston peninsula.

This photograph was taken by the wide-angle camera in NASA's *Tiros I* meteorological satellite during the forty-third orbit at 6 a.m. (EST), April 4, 1960, from an altitude of about 450 miles. The satellite was over the Red Sea looking towards the north-west. The dark strip at the left is the Nile. The Gulf of Aqaba can be seen at the top of the photo near the Red Sea. The Mediterranean is at upper left of the photo.

The National Aeronautics and Space Administration satellite, *Tiros I*, was over North Africa looking downward and to the west when this image was made of the Straits of Gibraltar (centre of picture). Spain is in the background; Portugal is covered by a cloud formation. In the foreground is the coast of Morocco and the western part of the Mediterranean coast of Algeria. The dark area on the right is the Mediterranean Sea. On the left is the Atlantic Ocean.

(Photographs by courtesy of NASA)

The **Soviet Union** recently announced its plans for the sixth Antarctic Expedition (which covers the 1960–1 season). Temporary bases are to be set up in the interior of Eastern Antarctica as bases for scientific exploration. Lazarev, the Atlantic coastal station established early in 1959, is to be built up into a major permanent base comparable with the Russians' prime base at Mirny in the Pacific sector. The site of Lazarev is to be transferred about 90 miles inland from its present position on the coast, to the foot of the inland mountains. During the forthcoming season


EARTH TRACE TRAJECTORY OF NASA'S PROJECT TIROS
LAUNCHED AND INJECTED INTO ORBIT BY THE UNITED STATES AIR FORCE
PROJECT TIROS ORBIT
1st ORBIT
2nd ORBIT
3rd ORBIT
4th ORBIT
ORBIT CODING MARKS ARE FIVE MINUTES APART NUMBERS ARE TOTAL TIME FROM INJECTION AT THIRTY-MINUTE INTERVALS
POINT OF VERTICALITY
18.85° N
45.09° E
EQUATOR

Earth Trace Trajectory of NASA's Project *Tiros*.

the Russians will use a heavy turbojet aircraft in the Antarctic for the first time. It is equipped for use as a flying laboratory.

Perhaps the most remarkable feature of the new Russian plans is that absolutely no mention is made of the projected 4000-mile trek across the interior that was to link the Geographic, Geomagnetic, and Inaccessibility Poles by seismic traverse. This season's visit by a Russian tractor train to the South Pole had seemed the curtain-raiser to this expedition. The project to establish a station on the Bellingshausen Sea also appears to have been dropped (see DISCOVERY, November 1958, March and December 1959, January 1960).

The Establishment of CIG

The ICSU organisation for co-ordinating international geophysical effort in succession to the IGY was launched on its career at the end of 1959. It has a new bureau (see box) and a new name, CIG, the initials of Comité International de Géophysique. Several of the leading figures from the days of CIG's predecessor CSAGI have retired after their sterling work to make IGY a success; notably Prof. Sydney Chapman, instigator and president of the IGY, and Prof. Marcel Nicolet, Secretary-General.

Prof. V. V. Beloussov, the able Russian geophysicist who played so large a part in IGY affairs, takes over the presidency of the new body from Prof. Chapman. General Georges Laclavère adds the CIG secretaryship to his many other posts. With the change, the headquarters of international geophysical co-operation shifts from Brussels to Paris. Prof. Nicolet, who describes himself as "just a simple scientist again", is now head of the newly established Centre for Space Research in Belgium.

The main provisions of the charter that has brought CIG into being are these: to keep the World Data Centres in operation and maintain their efficient functioning; to encourage the discussion and utilisation of IGY and IGC—1959 results; and to promote the development of further co-ordinated plans for international participation in geophysics.

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Photographing the Weather from Above

Tiros I, the try-out of the U.S. weather-satellite system that at last got into orbit on April 1, has proved a substantial success. The resolution of the televised pictures has been very fair (as may be seen from the accompanying figures). They have therefore conveyed sufficient detail of the cloud cover scanned by the orbiting satellite's cameras to be valuable to the weather men. This was not true of the previous successfully launched cloud-cover satellite (spring 1959) whose de-spin mechanism did not function properly so that a blurred image resulted.

The full potentiality of this vehicle has, however, been inhibited by two factors. One was that only two stations (in New Jersey and Hawaii) could be made ready in time to receive the pictures from the satellite and it is only within range of a station for a maximum of twelve minutes per orbit so that some data have inevitably been lost. A second difficulty has been due to the development on April 9 of a fault in the timing apparatus associated with the tape recorder connected with the narrow-angle (high-resolution) camera. This meant that only pictures taken by this camera in the immediate vicinity of the receiving station which could be transmitted direct were available from the ninth day after the satellite's launch. (As this camera was originally developed as an air reconnaissance tool for the Defense Department, however, the partial failure of this part of the system has probably been of more concern to the Pentagon than the U.S. Weather Bureau.)

A lesson for the future is undoubtedly the necessity to increase the volume and efficiency of the transmitting network which funnels these data from the collecting centres to the analysis and interpretation centres for use in forecasting. During the early days of the *Tiros I* experiment the channels into Washington were jammed by the volume of data coming in.

The most striking results apparent from the first tentative assessment of *Tiros I*'s findings has been the unexpectedly large degree of organisation in the cloud systems over much of the Earth. The spiral cloud formations associated with large storms have been shown to reveal striking patterns; spirals as much as 1500 miles in diameter have been observed over

the larger terrestrial surface masses, such as North America, the North Atlantic, both the North and South Pacific and over the Indian Ocean. Previously such spiralling cloud bands focused on storm centres had only been observed in the tropics in association with hurricanes. Now this structure is observed to be characteristic of well-developed storms located outside the equatorial latitudes.

A spectacular achievement of this satellite's monitoring system was the discovery of a fully developed and previously undetected typhoon in the Tasman Sea near Australia during the first week of the satellite's life. A photograph of this typhoon was obtained by the satellite and as soon as it was identified the Chief of the U.S. Weather Bureau cabled the Australian meteorological service so that precautions could be taken against it.

SPACE CALENDAR

MARCH

23 35-lb. U.S. satellite *Explorer VIII* failed to go into orbit from Cape Canaveral. Failure of second or third stage suspected. Designed to measure Van Allen radiation.

24 Newly developed Australian solid-fuel sounding rocket *Aeolus* reached 80 miles high in a night firing from Woomera.

28 NASA's semi-annual report announces that a "flashing-star" satellite is expected to be launched by autumn. 150 lb. and 3 ft. in diameter, it is intended for a 100-mile-high orbit and its intense light beam photographed against the stellar background will give geodetic measurement accurate to 100 ft.

APRIL

1 *Tiros I* cloud-cover TV satellite successfully launched.

2 *Tiros I* satellite photographed by Baker-Nunn camera at Woomera. Photo showed that the rocket casing was also in orbit travelling some 100 miles behind the satellite.

2–5 Severe magnetic storm causing world-wide long-distance radio communications failure. Measurements from *Pioneer V* during this period will be of the greatest interest.

6 *Sputnik III* entered the atmosphere and burnt up during its 10,037th transit.

7 GPO, in association with Cable & Wireless, is looking into the potentialities of earth satellites as relays for long-distance communications and television.

8 First manned flight in the *Project Mercury* man-into-space series due this year, according to Surgeon-General O. K. Niess, in charge of the space-medicine aspects of the programme. In this test a manned projectile will rise 300–500 miles high over the sea, in a ballistic trajectory.

9 $50 million rocket-range for NATO training to be established in Crete. Range limit: 150 miles.

11 About this time one of *Pioneer V*'s telemetry channels was observed to be faulty, producing garbled data. By 24th the circuit designer at STL had traced the trouble to a diode in the satellite and written a programme for an additional earth-bound computer to compensate the missing numbers to smooth the readings.

12 *Project Ozma*, the radio search for signals from other communities in space, initiated on the 85-ft. paraboloid at Green Bank Observatory, West Virginia. A night routine for some months will concentrate alternately on Tau Ceti and Epsilon Erindi, each about 66 million million miles away (11 light years).

13 Development of the British *Blue Streak* rocket as a defence missile is cancelled. This was announced by Minister of Defence, Mr Watkinson, in Parliament. Cost so far: £65 million. Amount committed: £100 million. Completed project estimated at £600 million. Reason given: the vulnerability of ground-based launching-pads. Alternative: ground-based V-bombers.

13 *Transit 1B*, first of the U.S. Navy's Transit series of navigational satellites, successfully launched from Cape Canaveral into 50° orbit. Orbit intended to be perfectly circular in fact varies between 460 and 230 miles high. Weight: 265 lb. Diameter: 26 in. Intended to prove a precise navigational system independent of weather, making use of Doppler shift of radio signals. Complete system will involve six satellites; could be operational by 1962. Cut present maximum "fix" accuracy from ½-mile to ¼-mile. Launching used an on-off-on rocket engine to give exact orbit, for first time.

14 U.S. Government announces that it is prepared to sell Britain the as yet undeveloped *Skybolt* long-range air-to-ground missile to arm V-bombers for the revised British defence policy.

15 *Discoverer XI* satellite launched from Vandenberg, but nose-cone not retrieved.

17 Sir Frederick Brundrett, scientific adviser to the Ministry of Defence until 1960, declares that *Blue Streak* is the "only means of satisfying the Government's policy of keeping her independent deterrent continuously until 1970. The desire to keep going an excessively large aircraft industry has for far too long bedevilled our military planning."

18 First model of *Scout* satellite-launching vehicle composed of two dummy stages and two operational stages, test-fired from Wallops. First stage 100,000-lb. Aerojet *Algol* worked; Hercules 10,000-lb. *Antares* (3rd stage) did not. The *Algol*, a modified *Polaris*, was the largest U.S. solid-fuel rocket ever flown.

18 Development contract worth $500,000 for one year awarded by NASA to Avco and General Electric Co. for a low-power, long-lasting electric rocket engine for year-long interplanetary missions.

23 First test-firing of *Atlas* from within "coffin" (concrete hangar). Vandenberg.

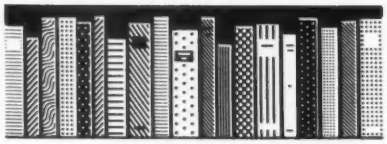
24 Dr Herbert York, Director of Advanced Research, U.S. Department of Defence, declares there is no value in a military base on the Moon for either U.S. or U.S.S.R.

25 U.S. Navy target *Drone* missile goes out of control after launch from Vandenberg. Expected to crash near Oakland; in fact descended in Pacific.

27 Prime Minister announces in the House that the adaptation of the *Blue Streak* missile as a space-research rocket is under review. The firms involved in the rocket's development have been asked to estimate costs.

28 Debate on the Opposition motion of censure on the handling of the *Blue Streak* project in the House of Commons. Government gained a majority of 80, some Conservative MPs abstaining.

30 Conference at the Royal Society on the possibilities of a pan-European space-research co-operation. Opinion favourable.



THE BOOKSHELF

The Upper Atmosphere

By H. S. W. Massey and R. L. F. Boyd (*London, Hutchinson Scientific and Technical, 1958, 348 pp., 63s.*)

There is one main difficulty for everyone intending to write a book on modern physics for the use of a widespread public: some modern notions common to every physicist and which can hardly be avoided are unknown to the public, even to an educated one. This is not due to some true difficulty in relation with these notions but to the simple fact that school physics are too closely based on classical problems, especially those which admit suitable mathematical solutions, so that fundamental notions of modern physics are quite unknown. H. S. W. Massey and R. L. F. Boyd, realising this difficulty, have overcome the same in a very clever manner: their book begins with a chapter on "the relevant physics", and this will certainly be very useful to many readers. There is a very good paragraph on electricity and magnetism, giving a very clear explanation on phenomena such as atmospheric dynamo effects and the Hall-polarisation, as well as the modern conception of longitudinal and transverse conductivity in a plasma. A second paragraph gives generalities on waves, a third one treats atoms, molecules, and gases. The laws of quantum mechanics are introduced in a rather formal way by equation "11"; if reference had been given to one of the specific experiments, for example the photo-effect, the necessity of introducing notions different from the classical ones would have been better understood. Considering the reader for whom the book is intended, it would seem desirable that specific examples were given of other phenomena under discussion.

After a short summary on the atmosphere in general we find a very pleasant chapter on balloons and rockets, and there is another one on satellites, and a final one on "future possibilities". No doubt this book is up to date—the recent development of satellites up to *Sputnik III* is mentioned. Engineering principles for rocket design and the different practical limitations are described in a very interesting discussion; problems like optimum combustion time, and liquid or solid propellants are treated. Scientific results of rockets have been introduced throughout the book, and there is a useful summary.

After a chapter on probing with sound waves, there follows one on probing with radio waves. The propagation of radio waves in a plasma is a rather complicated problem and it is certainly not easy to discuss in short terms at this level. Indeed some of the statements could perhaps be misunderstood by the proposed reader.

The next chapter gives geophysical results and an outline of the theory of the different layers produced by dissociation or ionisation. A few of these results can not be maintained any longer and should be replaced in a second edition.

We then find a chapter on lights in the night sky, including aurorae, with some nice colour pictures, a summary of results, an outline of theory, and even a discussion on artificially produced glows. Aerial tides and magnetic effects are described in the following chapter. There is a description of the different types of magnetic variations, a summary of the dynamo theory, and the modern theory of the F-layer due to Martyn. The solar, magnetic, and ionospheric disturbances is spoken of in some detail. The actual, yet unsatisfying situation of the theory of disturbances is frankly admitted. A clear outline of modern radio methods applied on meteor traces is given in a chapter on meteors. Finally, we find a chapter on cosmic rays, observation methods and geophysical effects.

A good deal of modern techniques and results considering the upper atmosphere has been assembled in this book, and clear explanations are given. This work certainly meets the urgent need for a book on this subject which may be accessible to a larger public. It may even be useful to the workers in this field. K. RAWER

Fish and Fisheries

By Sir Alister Hardy (*London, Collins, 1959, 322 pp., 30s.*)

To have read this fine book, with its sixteen plates in water-colour reproduced from the author's own brush and sixty-eight photographs in black and white (many by "that master of marine picture-making" Dr D. P. Wilson), has been the delight expected. Though its range is great, Prof. Hardy has contrived to tell his very comprehensive story in a gripping style which flows with surprising ease.

Though this is an ideal book to recommend to those who know next to nothing about the subject, it is, at the same time, one which will be a joy to those professionally concerned. Your reviewer is in a quandary: merely to list with the admiring comment deserved all the topics covered would absorb too much of the brief space available, yet, without doing that, to find fault in a few connexions would be as much out of proportion as would be adverse criticism of one button on a superb garment. We particularly admire the way in which Sir Alister manages to give a clear and simple treatment of the complicated overfishing problem. Amongst the highlights will rank the story of the great basking shark which loses its gill-rakers in winter. Any future edition will presumably have to take account of the exciting new hypothesis concerning the eel which has recently been advanced by Tucker. The author naturally has much to say about the very important vicissitudes of the great East Anglian fishery on the herring—a fish upon which he has himself worked so extensively. The chapter on "Whales, Walruses, and 'Wild' Men" is especially enjoyable to read. About the cetaceans we con the words of an expert of experience; about the "fin men" and their kayaks found on British shores we read things of compelling interest.

Wherever the author is dealing with commercial fish and fisheries, what is written is clearly from the pen of one who knows at first hand. We share with others the opinion that perhaps the most interesting chapter is the final one, in which Sir Alister deals with marine ecology and the future. Those who know him well will find nothing to surprise them in what today seem his flights of fancy but tomorrow may be practical ways of garnering harvests from the seas.

Your reviewer does not think Prof. Hardy has succeeded too well with his description of the Kullenberg piston corer, and sees much to criticise in what the author has to say about inter-relationships between adult fish and currents. In common with so many writers, Hardy tells a story which conveys too simply that deliberate fish travels are dependent upon residual currents. These have no individual existence, of course, in a sea

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like the North Sea, where they are merely the out-of-balance of perpetual to-and-fro tidal streams. J. N. CARRUTHERS

Ceylon Trees

By T. B. Worthington (*Colombo, The Colombo Apothecaries Co., Ltd., 1959, xi+440 pp., Rs. 40*)

This volume consists of a series of photographic plates illustrating 429 species of trees found in Ceylon. Each plate is accompanied by the Latin and vernacular names of the plant depicted, together with very brief notes on distribution, habitat, habit, and some features of bark, leaf, flower, fruit, and timber—these amounting to only a few words. The arrangement of the species follows that in Trimen's "Handbook to the Flora of Ceylon" (1893–1900). The nomenclatural changes appearing in Alston's supplementary volume of 1931 have been incorporated. References to the page of the key to the genus concerned in Trimen's work are given throughout. The species illustrated were chosen from the total of over 600 tree-species given by Trimen and they also include a number of additional species which have been introduced.

The photographs, measuring 10 × 10 cm., are all of the same scale, being one-third of natural size. Leafy branchlets are shown, mostly bearing flowers or fruit. A number of the specimens depicted are sterile, which is perhaps to be expected seeing that some of these species are uncommon and produce flower and fruit at irregular intervals. It appears that the material photographed was living. There are, however, some trees which surely need not have been illustrated in a sterile condition, for example *Vernonia arborea*, the locally rather common Composite tree. The sterile specimen shown under *Durio zeylanica* (an error for *D. ceylanicus* Gardn. which is a synonym of *Cullenia ceylanica* (Gardn.) K. Schum.) is probably *Cullenia rosayroana* Kostermans, since the leaves are too large for the former species.

The plates, which were prepared in Ceylon, vary considerably in quality. Judged by present-day standards, the reproduction is frequently poor, sometimes with much detail lost, although many of the plates are adequate for comparing with specimens.

This book, said to be intended for newcomers to the flora who wish to identify some of the trees of Ceylon, is presumably intended to be used in conjunction with Trimen's five-volume work. By itself, its use will have certain limitations. As an illustrated addition to Trimen's flora this volume will be a useful aid to the determination of many of the trees found in Ceylon. L. L. FORMAN

Behavior and Psychological Man

By E. C. Tolman (*Berkeley, University of California Press, 1958, xiv+269 pp., 17s. 6d.*)

Prof. Tolman presents us, on page 172 of this book, with a "confession of faith". He writes:

> "I believe that everything important in psychology (. . . save such matters as involve society and words) can be investigated in essence through the continued experimental and theoretical analysis of the determiners of rat behavior at a choice point in a maze."

This identifies the writer as an arch "rat-psychologist". A reader, unfamiliar with Tolman's work, might then ask two questions. First, do the "determiners" of behaviour include the internal processes, usually studied by physiologists, which influence behaviour? An answer comes on page 189, where one finds the conclusion: "psychology today is . . . in some considerable degree ancillary to physiology". This turns out to mean that "an adequate psychology is a precondition to a complete physiology." The second question is: what are Tolman's views on the study of the behaviour of animals going about their ordinary pursuits in "complete" environments? Here the answer is rather different: it is suggested in the remarkable and quite erroneous statement (page 229) that rats have "very little social life". This assertion in fact holds only for tame rats in typical laboratory conditions.

From this evidence then, it might be concluded that Tolman is an exponent of an arid, blinkered science of behaviour, with little to say except to the jargon-ridden contributors to the *Journal of Comparative and Physiological Psychology* (most of whom write about tame rats). In fact, this is far from true. For many years (this collection of papers covers 1922–48) Tolman has been writing provocative, entertaining and often brilliant discussions of some of the most difficult and important questions raised by experimental work on behaviour. The subtitle of the present work is "Essays in Motivation and Learning", but it ranges from an early discussion of "instincts" to a lively essay on "psychological man" which turns out to be an incursion into ethics.

Tolman is one of those agreeable American writers who look back, from time to time, on what they have just been writing and ask, in effect, "Now why did I write that?", or "Just what does that really mean (if anything)?" This style is perhaps a reaction from the perfectionist

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formal and utterly dreary manner of most papers on behaviour or psychology: it is conversational, human, sometimes witty and, when wrong, engagingly so. Many who thoroughly disagree with Tolman about what he calls "expectancy" have enjoyed, or will enjoy, his essay weirdly entitled: "A stimulus-expectancy need-cathexis psychology", of which the peroration includes this:

> ". . . let it be noted that rats live in cages; they do not go on binges the night before one has planned an experiment; they do not kill each other off in wars [not much, anyway: S.A.B.]; they do not invent engines of destruction . . .; they do not go in for either class conflicts or race conflicts; they avoid politics, economics, and papers on psychology. They are marvelous, pure, and delightful."

All members of that disreputable species, *Homo sapiens*, who are interested in behaviour, should read this book.

S. A. BARNETT

The Transits of Venus

By Harry Woolf (*Princeton University Press, 1959, xiii+258 pp., illustrated, 48s.*)

One of the greatest problems facing early astronomers was that of determining the length of the astronomical unit, the distance between the Earth and the Sun. One method was to make use of the rare occasions when the planet Venus passes across the solar disk. Such transits occur in pairs, and are separated in time by more than a century. The present work deals with the transits which took place in 1761 and 1769. Only two transits of Venus, those of 1874 and 1882, have occurred since.

The book is well summed up by its sub-title, "A Study of Eighteenth-Century Science". The transits were important not only for themselves, but for the impetus which they gave to international scientific collaboration. Moreover, the various expeditions also carried out other researches, ranging from longitude-determination to oceanography.

The book is of an extremely high standard, and, in fact, cannot be faulted. The text is very readable, and may be followed by the layman, while the references are so complete that the historical student will find the book invaluable. A vast amount of original research has gone into its compilation, and the author is to be congratulated upon producing what will undoubtedly remain the standard work upon this subject.

P. MOORE

The Catalyst

By G. O. Jones (*London, Faber & Faber, 1960, 173 pp., 13s. 6d.*)

This novel, the author's first, has a scientific background against which we see the struggle of a young chemist to secure a position and to make a success of his marriage.

The story is told in the first person singular, one of the most difficult forms for a novelist to undertake. While his descriptions of the work and personal relationships in a large firm are interesting and authentic, his characters as seen by the young scientist do not live and it is difficult to believe that the women, in particular, are real people.

Novels of this kind require insight and skilled powers of description such as C. P. Snow has shown in "The New Men". G. O. Jones does not yet possess these attributes.

P. A. HABER

Automatic Data Processing

If ever a subject needed explaining in clear language to non-specialists, it is that of using computers in industry and in industrial management. The subject is inherently difficult to grasp for non-mathematicians, and is rapidly becoming enveloped in a peculiarly verbose jargon of its own. The new journal in this field, *Automatic Data Processing*, it is good to hear, is addressed directly to the intelligent, non-specialist reader. All the same, apart from oddities such as "debugging", the reader is still left to wrestle with expressions like "semantically different homographs", "ferrite core storage", "partial word field operation", and "buffered bi-directional tape-search operations". With a new journal like this, however, the debugging will almost certainly still be continuing, so that we can hope for an improvement in the future.

The Principles of Electrophoresis

By René Aububert and Serge de Mende, translated by A. J. Pomerans (*London, Hutchinson & Co. Ltd, 1959, vii+142 pp., 25s.*)

Electrophoresis: Theory, Methods, and Applications

Edited by Milan Bier (*London, Academic Books Ltd, 1959, xx+563 pp., £5 7s. 6d.*)

The last decade has seen an ever-increasing application of electrophoretic techniques for the separation of chemical substances and today these methods are used not only in research projects but also for routine testing purposes. The greatest advances have been made in paper electrophoresis, a technique whose popularity, as Aububert and de Mende point out, "spread widely and rapidly, almost too rapidly one might say, since it was put into use before the physical foundations of the method had been firmly established. As a result, quite wrong interpretations of the outcome of an experiment were sometimes made." Much more is now known of the fundamental principles of electrophoresis, and the publication of both these books is timely. Each in its way will fill a much neglected gap.

Aububert and de Mende, in their short book, have succeeded in giving a clear and logical description of the physical theory underlying electrochemical separation in all its different forms. This account provides an excellent introduction for the reader who wishes to obtain an overall view of the subject. However, it seems to the reviewer that, even in a work dealing essentially with general principles of a scientific technique, more space should have been given to the applications of that technique to practical problems. The last chapter of the book, which is devoted to this aspect of the subject, is much too short. The number of references taken from an increasing and formidable bibliography is relatively small and less than adequate.

By contrast, the book edited by Milan Bier sets out to be a comprehensive treatise on the theory, methods, and applications of electrophoresis. Each of the eleven sections written by different well-known workers in the field is well documented with practical details of the various techniques. A very complete list of references of applications of the methods is given at the end of each section. The book as a whole is excellently produced with many clear figures and diagrams, and it may well become a standard work of reference on electrophoresis.

J. WHITEHEAD

Mechanical Engineering Research, 1958

Department of Scientific and Industrial Research (*H.M.S.O., i–iii, 67 pp., 4s. 6d.*)

It may be recalled that whereas the Council for Scientific and Industrial Research recently recommended that the work of the newly renamed National Engineering Laboratory, whose Report this is, should be continued and expanded, it also urged that the laboratory's work should be focused *inter alia* on practical objectives; that where development work is undertaken it should be carried out in co-operation with a user, and that major projects should be few, with effort more concentrated and progress more rapid. It

is significant to learn that the budget allows for an increase in staff of 60% during the DSIR's second five-year plan (1959–64), and that new laboratories for the study of high-temperature creep and fatigue, for plasticity, and for lubrication and wear will be brought into operation. The laboratory, as a unit, fully realises that in its case, perhaps more than in any other, the results of research work are of no value until they are applied by industry. Extensive steps are therefore taken to disseminate the results of its researches, not least by the participation of its staff on the appropriate committees and sub-committees of the British Standards Institution.

The Report contains by way of appendix a most comprehensive statement on the laboratory's research projects. This is preceded by a more detailed discussion of twenty items in the laboratory's research programme, much of it unique in character and quality. Unquestionably, these serve to spotlight the field of operations of the laboratory's six divisions which deal respectively with the properties and strength of materials, particularly fatigue and creep; fluid flow problems of pumps, water-turbines, and other hydraulic machinery; lubrication, wear, and mechanical engineering aspects of corrosion; mechanisms, engineering metrology, and noise control; the plastic deformation of metals in machining, extrusion, forging, and other metal-working processes; and heat transfer and applied thermodynamics.

Yet whereas it may be considered to be a most useful Report from the specifically technical viewpoint, the director's statement does not indicate with sufficient clarity how far the laboratory's strategy is directed to meet current economic and industrial priorities. Thus, while the narrative contains useful introductions to the general setting of the research activities of the laboratory's division, emphasising, to paraphrase the Report, the significance of the engineer's knowing what stress his components will stand, of the British hydraulic machinery industry more effectively meeting competition through a clearer understanding of the principles affecting the design and operation of various hydraulic systems, that the economic consequences of wear grows as capital investment in machinery increases, that it is important to reduce power losses and noises through the operation of mechanical devices in everyday engineering, and of the existence of plastic deformation of the material in the manufacture of almost all metal articles. There is none the less no detailed account submitted of an economic or industrial strategy for the laboratory's activities. It is to be hoped that this important function will not be neglected by the DSIR and its Council, and that for future appraisals of the laboratory's undoubted achievements we shall not be denied this indispensable clarification.

The House of Intellect

By Jacques Barzun (*London, Secker & Warburg, 1959, 276 pp., 32s. 6d.*)

In vain has Jacques Barzun stated in the opening paragraph of his study "The House of Intellect" that his argument applies to the whole Western world and, as he says "to any nation that adopts egalitarian democracy, mass education and journalism, the cult of art and philantrophy, and the manners coincident with these". Any reader will agree that his book is a critical, and undoubtedly cynical, analysis of American culture. But since American culture is the most dominant in the Western world, Prof. Barzun's dissection of its intellectual potential is of wide interest.

The author makes a sharp differentiation between intelligence and intellect. The modern educated democrat, he admits, is intelligent, but for that matter so are apes and bees and perhaps fishes and flowers. This democrat is criticised because he neglects one form of intelligence which is Intellect, or intelligence stored up and made into habits of discipline, signs and symbols of meaning, chains of reasoning and spurs to emotion. Americans, because they lack Intellect, are accused by the author of finding it difficult to judge persons and ideas; of being afraid of criticism and of being inept in conversation; of having a school system in a ridiculous state of paralysis; and, strangely enough, of being inept in large collective enterprises like the production of rockets and satellites. The latter accusation is hard to comprehend. America's recent belated acknowledgement of the solution of the ICBM, not to mention her handling of the Manhattan Project, and scores of other projects of which the Marshall Plan was a large collective enterprise of the highest intellectual order, make this statement border on the absurd.

Anyone who has lived in America does not need Prof. Barzun to tell him that on the surface American society presents the appearance of a vast wasteland devoid of Intellect. Academic inanity is also prevalent. America is so vast and so complex and so rife with paradox that to find out the truth about it is well-nigh impossible. Much of what Prof. Barzun says is true, but he is continually guilty of weakening his argument by introducing red herrings like his criticism of collective enterprises mentioned above. Another case of this is his unjustified attack on the photographic essay "The Family of Man" which was sponsored by the Museum of Modern Art. In this case, the criticism is based on the neglect of the camera to record the Intellect of Man.

In the mid-20th century Prof. Barzun finds Intellect assailed by the unholy triumvirate of art, philanthrophy, and science. Art, particularly in education, is represented by the "creativity", recognised by modern education as sacrosanct in the young uninformed mind. Philantrophy means "the liberal doctrine of free and equal opportunity as applied to things of the mind" or in other words the egalitarian doctrine of education practised in a democracy. In this respect, Prof. Barzun would disagree wholeheartedly with the recent plea by Dr Bowden, the Principal of the Manchester College of Science and Technology, for more educational opportunities for more students. Science is a villain in the piece because scientists, in the name of untrammelled inquiry, have planted citadels throughout the realm of the mind, but have taken no thought of the means of intellectual exchange among them. This observation is only too true, and unfortunately only too few scientists recognise it.

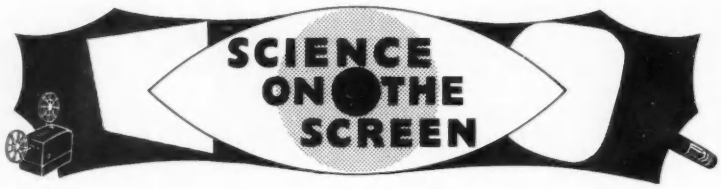
While Prof. Barzun is an intellectual Pharisee, his analysis of the dangers facing the culture or Intellect of a free society are challenging, albeit ruthless. He has consistently reinforced his arguments with the recognised weakness in the American system and has ignored those aspects of America which are its strength—not the least of which is the opportunity it offers for the development of Intellect.

H. HARVEY

The Boy Scientist

By John Lewellen (*London, Phoenix House, 1958, 268 pp., 18s.*)

This book explains scientific method and the laws of physics to children in terms of games, everyday phenomena, and other subjects which interest them. Thus, Newton's three laws of motion are explained in terms of space rockets, cricket, and boating. Mr Lewellen frequently urges the reader to test the laws of physics for himself, where practical, and often suggests experiments to this end. Science from Galileo to Einstein is covered in twelve chapters; chapter thirteen is a discussion of the science of the future. Although written for children, this book would be very useful to the adult layman with no scientific background.



A Lecturer on Film for University College, London

The importance of the Film, both as an art form in itself and as one of the most powerful means of communication in the modern world, gives it the clearest claim to the attention of universities where, moreover, it can often be highly relevant in the study of long established subjects such as Fine Art, Psychology, Economics, and Education. While for some time the Film has been considered an appropriate subject for study in universities in America, France, and Germany, it has, up to the present, found no place in a university in England. Now, however, the subject is to be introduced in the University of London. Through the good offices of the British Film Institute, generous grants have been made to University College London by the British Film Producers Association, the J. Arthur Rank Group Charity, and the Associated British Picture Corporation to support the study of and research in the Film. It is felt that University College, with its many departments ranging through the Arts and Sciences, will provide a peculiarly favourable setting for the introduction of this study.

The scheme proposed involves the appointment of a Lecturer who will be attached to the Slade School and will have facilities for showing films, lecturing, research and the supervision of postgraduate students. No undergraduates will be registered for the subject, but the scheme provides funds for the establishment of two postgraduate studentships. It is hoped to attract to these studentships graduates who wish to undertake research on some aspect of the Film.

Apart from postgraduate work, it is proposed to conduct courses of lectures and seminars on the Film. Some of these courses will be given by the Lecturer himself and he will also have at his disposal funds to allow him to invite experts from outside to assist in the work.

The appointment of the Lecturer will be from the beginning of the Session 1960–61 when the scheme will start, and it is hoped to announce the terms of application for the Postgraduate Studentship very soon.

It is proposed to limit the duration of the scheme to a trial period of five years, at the end of which time it will be reviewed.

Underground Waters

16 mm. Colour. Sound. Running time 19 minutes. (*Produced by the Film Section of the Belgian Ministry of Education. Re-edited by the Educational Foundation for Visual Aids, in co-operation with the National Committee for Visual Aids in Education. Adviser: Donald Taylour, M.A., F.R.G.S. Distributed by EFVA, 33 Queen Anne Street, London, W.1*)

The film is one of a series, "Physical Geography for Schools", produced by the Brussels Treaty Powers. It is intended for an age range of from twelve to fifteen years. It is the last of the series produced by international co-operation under the auspices of the Brussels Treaty Powers. In the same series are *The Changing Coast*, made by England and Wales; *Volcanoes*, made by Scotland; *Glaciers and Their Work*, made by France; and *Coastal Dune Formation* by Holland.

A large part of the film was made in the Karst country, near Vaucluse in southern France. On the whole, the colour photography, both real and animated diagram, is most effective, although Kodachrome loses much of its pristine glory when reproduced from a duplicate master.

The film opens with the familiar water-cycle. It appears to assume that this is already known and that the introduction is merely a revision. A diagram would have probably helped to recapitulate the idea of evaporation, cloud formation, wind moving clouds, rain falling, and water flow. It then goes on to explain what happens to the water that sinks into the ground.

It gives clear, simple, animated diagrammatic explanations of springs, ground water, and the geological formations which produce underground drainage. Hot springs are demonstrated and explained. How the ground is fissured in carboniferous limestone by the acid content in the rain-water and soil is clearly shown. This leads to the formation of underground water-courses. Some of these run through channels with air space above, others completely fill the "pipe". These latter are called "syphons". The film continues to show the exploration by speleologists of an underground waterway, following them going down narrow pipes with the help of rope ladders, and navigating streams by means of inflatable craft. When the stream has silted up, they have to drag, or lift, their craft over the barriers. Finally, when they come to a syphon they don frogman's kit and swim underwater through the final syphon into an open-air lake.

This section is beautifully photographed and the lighting problems for the film-maker must have been tremendous. Your reviewer was told that the film was suspended for some time because there was a fatal accident in the caves.

There is one major criticism of the subterranean sequence. The music was solemn, almost ominous. It was of the type with which both television viewers and film-goers are all too familiar. It was the "harbinger of evil" genre. It made one feel expectant, waiting for a boat to sink, or a ghost to appear. While it was playing, it completely negated one's objective, scientific attitude towards the film. It showed conclusively the importance of the complete purposeful integration of sound and sight. It would be very tempting to use mood music to stress the drama of the visuals, but it made the story too strong for the teaching message.

The film ends with a very brief recapitulation of the water-cycle.

The teacher's notes are as good and as efficient as are all those issued by EFVA. They give a summary of the content of the film; then they give the complete commentary, which can be most helpful to the teacher. In the additional notes, they suggest what preparation should be made before using the film, giving suggestions both for lower age-groups and more advanced students. They also suggest a simple experiment to demonstrate the effect of dilute acid on limestone. They give examples of similar formations to the Karst country in Britain. These are to be found in the Malham area of the northern Pennines, the southern Pennines, and the Mendip Hills. Finally, they give a bibliography of textbooks and suggested further reading.

Your reviewer has gone into some detail about the teacher's notes because they could well be studied by other makers of scientific films and filmstrips before they produce their own notes.

It is interesting to see the potential development of international collaboration in producing material of this sort. This film, and the others in the series, would be equally valid for teaching use in any part of the world. The only difficulty is the dubbing into another language and the consequent necessity for the production of a duplicate negative or master. There is no doubt that the use of

colour in this film added greatly to its interest and teaching value, although it must have increased the production difficulties. L. GOULD-MARKS

Alert

Sound. Colour. Running time approximately 75 minutes. Produced by Moscow Documentary Film Studios, Chief Director Boris Lyakhovfky. (*This film is for sale from Sovexport Films, 10 Kensington Palace Gardens, London, W.8.*)

This is a feature-length documentary, beautifully photographed in soft colour. The commentary is in English, the titles and subtitles are all in Russian, except where they use the device of translating phrases into many languages to show the internationality of the project. It is always disappointing to have to see a translated version of a film. Its initial force and purpose must be, to some extent, emasculated.

Visually the greater part of this long film is satisfying. The editing is competent, to say the very least, and the colour is well matched. Although at times a little brash, the commentary is effective and the music indicates that the sound track would have been much more integrated in the original Russian version.

As to content—it is an exciting and apparently factual account of the almost inconceivable progress made since 1957. Somewhat naturally we start with the Sputnik and the immense number of ordinary people and scientists who tracked or tried to follow its progress across the skies. There is humanity in the faces of ordinary Russians using almost every kind of optical device to search the heavens.

A sideline, but an instructive one, was to discover that the cameramen were provided by the "Moscow Film Studio for Popular Science". This indicates the thoroughness with which the Soviets approach the dissemination of scientific information.

Although the film stresses the Soviet contributions to the IGY it also shows the contributions made by other participating countries. When demonstrating a particular project they show maps and jump in the flags of the countries taking part.

The history of geophysical research and how it has grown out of straight exploration in the old style, is very clearly shown by an assemblage of old newsreel coverage. After beginning in modern colour, showing the latest equipment, and after very effective animation of the satellite's progress, it was extremely convincing to see shots from the beginning of the century. We see Amundsen, Byrd, and the Russian explorers in dirigibles and dog sleighs. Then we come to modern Arctic and Antarctic exploration with tractors, helicopters, and "every modern convenience".

The most impressive thing about this record is the extent and variety of the researches carried out. People are working painstakingly day and night in freezing cold and tropic heat to fill in gaps in scientific information. An irritating feature is the vast number of names of individual research workers quoted. This is not only because Russian, Czech, and Chinese names are difficult to catch; it is also because it is almost impossible to remember thirty or forty names shot at one during a single film. On the question of personalities it is surprising to see, as part of ships' crews, working on mountain glaciers, in the air, and in the Polar region, that there are always women scientists on the job. Many of these women were surprisingly young and attractive.

The study of the Earth's composition by the use of gravimeters, the quantitative measurement of ice to discover if it can be used to irrigate the arid lands and the study of weather in all its aspects are clearly shown. That is, clearly shown from a cinematic point of view while admirably indicating the scope of the investigations being carried out.

The sequence on oceanography shows the use by the Russians of an entirely non-magnetic ship and a whole fleet of other vessels. By this stage the audience appeared to be numbed by the impact.

Rockets, balloons, aircraft, and permanent stations investigate the weather. First-class animated diagrams show details of the Earth's winds and movement. One of the highlights of the film is the section on sun-spots. Because 1957 was a year of maximum sun-spot activity (an event occurring every eleven years), it was chosen as the IGY. The sun-spots were photographed and their effect on the ionosphere on short-wave radio, and on the Earth in general was shown by animated diagrams. The one defect is that the sun-spot is shown to grow into a vast scimitar which sweeps the universe and changes into a stream of particles. This could easily mislead those to whom a popular science approach is essential.

The training and adjustment of Laika and her canine colleagues were shown in great detail. The commentary justified the use of dogs. Certainly when the dogs were taken out of a compartment which had descended by parachute, they seemed perky. One of them even begged for the titbits she was offered.

What does a film of this sort leave in retrospect? It has nothing to do with the film being Soviet, but it has a lot to do with the impact of these films. Your reviewer took notes during the film, but did not look at these until he had tested what he could remember. Certain scenes stood out very clearly; a colour shot of the Aurora Borealis; a white dog in a space-helmet being whirled round in something straight from Luna Park, and a particular ice formation shimmering in torchlight.

These recollections are of trivia. The human mind when faced with a vast canvas of this kind seeks security in simple details. It also seeks escape when too much is communicated at one time. The overall impact is overwhelming. There is the sense of international collaboration in a tremendous scientific research. Whatever one's feelings towards the U.S.S.R. may be, this record of achievement is stimulating. It should make scientists of all nations anxious to play their parts in this deeper exploration of the universe. L. GOULD-MARKS

Première for Heyerdahl's "Aku-Aku" Film

King Olav, Crown Prince Harald and Princess Astrid were present when Thor Heyerdahl's new sensational film *Aku-Aku* had its world première in Oslo recently—ten years after the first showing of his famous film from the Kon-Tiki Expedition. The new film is a feature documentary of his archaeological expedition to Easter Island. The book (see DISCOVERY, 1958, vol. 19, p. 314), a popular description of the expedition's work, has gone round the world already and now the film follows. At the present time Heyerdahl is working on the scientific material from the expedition, which will be published in English in two volumes. The critics of the Oslo press gave the film an enthusiastic reception.

The New V Brick

16 mm., colour, sound, 18 minutes. Produced by the Building Research Station of the Department of Scientific and Industrial Research. Script directed and edited by J. Rogers; camera, D. Gifford. (*Available on free loan from the Film Officer, Ministry of Works, Abell House, John Islip Street, London, S.W.1, or from the Local Regional Ministry of Works Office.*)

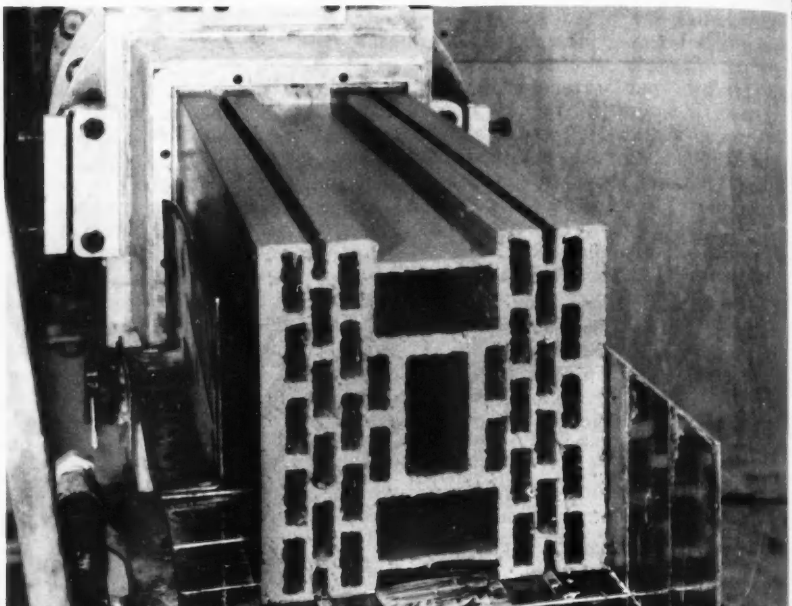
Throughout the world the brick is undergoing competition from newer building materials. In order that clay can retain its position against other forms of construction, it must be turned into new kinds of bricks. A team consisting of clay technologists and architects has visited Europe to study the design and use of perforated bricks for all purposes, including load-bearing.

As the result of this research and scientific study of moisture resistance,

thermal insulation, and strength, a new brick has been developed in the laboratory. Tests indicated that this new brick was likely to be satisfactory, so they persuaded the local authorities at Aylesbury to try it, to see how the ordinary contractors reacted, to what is, in effect, a double brick which needs different methods of mortaring and laying.

The V brick is perforated vertically by a series of oblong channels, and is so constructed that a cavity wall can be made in one operation. The front and the back of the brick look, on the surface, like ordinary bricks, but they are joined together by clay members which leave considerable air space between the two parts of the bricks (see illustration). The V stands for vertical perforation.

The brick is at present in limited production industrially. This is the fifth design, and it has to be modified to suit the composition of local clay. The bricks are extruded and wire-cut. One of the problems has been that the perforations have made the green brick fragile until it is baked. It is easy and quick to fire and dry because of the large amount of exposed surface.



Extruding perforated bricks at the Building Research Station.

(Crown Copyright)

Now to the film. It was made by technicians and scientists for an audience of their peers. It shows the earmark of this functional purpose. There is none of the usual groping for a story. The hero is quite simply the brick and no individual human is allowed to raise his ugly head. It is a pleasure to see a film which follows Lewis Carroll's advice, "Begin at the beginning, and go on till you come to the end; then stop."

With no pretensions to artistic use of colour or composition, and no editing tricks, it shows the research and development of the brick. Between sequences simple sub-titles are used. On each is a sectional drawing of the brick. This is a useful reminder to the audience of the subject being demonstrated. It is unobtrusive but is an excellent communication device. Every time your reviewer saw this drawing it helped him to understand the ensuing section of the film.

It is well to remember when creating visual aids, or even when writing or speaking, that a degree of well concealed redundancy in communication helps the memory. This is especially true when dealing with proverbially conservative people, like building contractors and architects.

The film shows that on the Continent, where these bricks are used extensively, they are mainly externally rendered. Most outside walls are covered with stucco, or other material, and bare brick is much rarer than it is here. In this country when brick is used it is usually left exposed. The film goes back into history to show how attractive, and how durable, brick can be. It even shows a 900-year-old church which was built from Roman bricks already ancient. Very cleverly it shows a house, nearly a hundred years old, built with hollow bricks. Without special pleading some objections are overcome before they are voiced.

A demonstration of the resistance of the brick to water is shown at the Building Research Station Laboratory. It is most convincingly photographed. The section on the thermal insulation is clear, but not as well worked out as that on the rain penetration test. The testing of the strength of the brick is shown as are all strength tests. The bricks tested in the film break at 3000 lb./sq. in., when the requirement is usually 400 lb. for a two-storey house. Having shown quickly and clearly the development of the brick and the reason for it, the film moves on to the method of laying. By means of well angled, reasonably close shots, the details of method of putting on mortar (which gives a 20% saving) and laying the bricks are clearly demonstrated.

Compared to so many industrially sponsored films, the honesty of this one has impact. It is objective and shows disadvantages as well as advantages. These bricks cannot be cut, though they can be split lengthwise. Transport tests are shown, the building of bungalows at Aylesbury and a factory in London are used as examples. Prototype manufacture on a small scale at the Research Station is also demonstrated.

Your reviewer has dealt with the film at some length because, of its kind, it is one of the clearest and the best he has seen. It is made by a part-time film unit, almost certainly on a very low budget. Because the problem has been thought out clearly and the approach has been direct and simple, it comes out as a first-class piece of logical exposition. It is aimed at a target which it will certainly hit, if the discussion which arose after the film can be taken as a guide.

Unfortunately there is always a fault. In this case it was the commentator, fortunately anonymous. He has a good voice: resonant, clear, pleasant, but it reeks of TV commercials and advertising trailers. Obviously the commentary meant little or nothing to him and he used his voice with the same stereotyped nuances as he would if he had been talking about cosmetics, or a new toffee.

The commentator is not to be blamed, neither really are the film producers. The trouble was that they did not use the sound-track with the same logical intelligence as they used the image.

L. GOULD-MARKS

Airborne TV Courses to reach Classroom of 5,000,000 in U.S.A.

What could have been a science-fiction writer's dream a generation ago will come true this year when schools in six States in the Middle West of the United States will tune in to televised classroom courses beamed from a four-engined airliner circling some thousands of feet above.

The experiment, financed by private gifts from foundations and industries, has been announced by the Midwest Council on Airborne Television Instruction. Starting in autumn, programmes will be broadcast from Purdue University in Lafayette, Indiana, and relayed to the flying TV transmitter 20,000 ft. overhead which will re-transmit them to an area of 300 to 400 miles in diameter.

The use of the huge airliner will enable telecasters to reach a far greater region than if they had transmitted their programmes from a ground station. The Midwest Council's scheme will bring 13,000 schools and 5,000,000 students within range of one TV transmitter.

Schools and colleges participating in the experiment on a voluntary basis will have a choice at the outset of twenty-four half-hour lessons a day. Courses offered will be both at elementary and at secondary level, and a few at college level. Programmes will be recorded in advance on video tape either at Purdue University or in other American educational TV production centres. Each course will consist of about 144 half-hour lessons during a school year.

At the beginning of the experiment two transmitters will relay two different programmes simultaneously from the aircraft. But the "airborne" TV classes will also represent a technical innovation in what is known as "narrow-band" telecasting. Each transmitter will be able to broadcast, over a single channel, two different courses at the same time. In this way it may eventually be possible to broadcast six different courses simultaneously, and to provide schools and colleges with a wide choice of programmes.

Describing the experiment, Dr Samuel M. Brownell, former United States Commissioner of Education and Chairman of the Midwest Council on Airborne Television Instruction, has called it an attempt to meet "the challenge which faces American education today . . . the challenge to provide a sufficient quantity of educational opportunities for a fast-growing population along with improved quality of instruction—and to provide both within feasible costs."

The estimated total cost of the experiment for the purchase of equipment and the first year of broadcasting is nearly $7,000,000. Depending on the number of schools reached, its cost per pupil has been forecast as varying from between $1 and $10 per year.

April Television

The producers of "Eye on Research" on BBC television, whilst offering us on the whole some very good material, yet seem to possess a natural gift for irritating anyone with a serious approach to scientific research. In this year occurs the tercentenary of the foundation of the Royal Society, an event of sufficient significance in the world history of science to be celebrated here later by the presence of the Queen and by attendance from a great number of universities and learned societies, indeed from at least forty-seven countries. So we find that "Eye on Research" announces a series on the current work of Fellows of the Royal Society. Since there are no less than 640 Fellows, most of them actively engaged in research, it becomes patently obvious that but a tiny fraction of the researches conducted by Fellows will be described. But of course this is by no means adequately stressed, nor is any real indication given as to just why particular researches have been arbitrarily selected for description. An impression is given, accidental no doubt, yet none the less unfortunate for that, that a cross section of the activities of the Fellows of the Royal Society is being surveyed. To do this adequately would need much more than the handful of broadcasts available, and indeed there is a certain misrepresentation here in not emphasising the position more specifically by a brief introduction to each programme. It would take but a few seconds and put the matter in correct perspective.

Now your reviewer has on many an occasion in the past condemned the catch-penny titles used so frequently by "Eye on Research", but their producers certainly reached a peak limit in fatuous invention of title, when they described some current research work on the common cold virus as "The Sniffle Group". We note too that this programme was also billed under the sub-title of the Royal Society Tercentenary Year. Your reviewer's objection to such crude humour is by no means to be attributed to academic pomposity, which he is the first to condemn. On the contrary, this objection is based on the fact that this constant weak punning and rhyming in search of a catch-penny title, is a very real reflection of the approach of the producers to their subject matter. It would almost appear, from the titles chosen, that to them scientific research is first and foremost to be treated as a matter of entertainment. One must vigorously protest at treating what ought to be serious scientific broadcasts as material for entertainment. One can but repeat what has formerly been said here, namely television has essentially, in increasing value, four possible functions: to entertain, to inform, to instruct, to educate. It will be a bad thing if the televising of scientific research drops to the bottom of this scale of values and becomes mere entertainment. No doubt the inventors of the title had much glee and satisfaction in getting so close to Skiffle Group when describing research on the common cold virus, but such elementary comedy is quite out of place in the context of serious scientific research.

Outstanding amongst the recent "Eye on Research" programmes was the recording, televised on April 19, of the works of Sir Frank MacFarlane Burnet, O.M., F.R.S. from Melbourne. We had of course the usual catchy title, this time it was that "Man against Himself" although just what that enigma really means, remains still unsolved. Sir Frank Burnet gave an outstandingly brilliant exposition. He discussed lymphocyte action and in a subtle, clever manner led us through to the consideration of the mechanism of such diseases as arthritis and their possible origins. From beginning to end he was a model of lucidity. It is a matter for interesting comment that the more distinguished the exponent usually the more lucid is his account. It is the young inexperienced research worker who is usually hopelessly obscure, bogged down in technical terminology and explaining nothing. Notable was the profound comment at the end made by Sir Frank Burnet, for after drawing attention to the fact that we had not seen any impressive big machines in his broadcast, he concluded "Thinking is still the most important part of science". This truism deserves to be thoroughly digested by BBC science producers.

Despite the fact that this broadcast was most serious in purpose, and treated in a scholarly fashion throughout, we were treated to the usual extra of entertainment. Why this particular programme from Melbourne should have ended with the popular Australian marching song "Waltzing Matilda" is most curious. Are we going to hear a succession of popular airs or national anthems if the scientists concerned happen to live in different parts of the world? It certainly does look as if the "Eye on Research" producers are out to squeeze every drop of entertainment they can out of their material, however unpromising it might seem from this angle.

S. TOLANSKY

FAR AND NEAR

The Nuclear Technology Laboratory of the Imperial College of Science and Technology, South Kensington, showing some of the special equipment used by postgraduate students.

(Photograph by J. P. Jennings)

Foreign Members of the Royal Society

At a recent meeting of the Royal Society the following were elected Foreign Members of the Society:

BEADLE, PROF. GEORGE WELLS, Chairman of the Division of Biology, California Institute of Technology, Pasadena, California, U.S.A. Distinguished for his outstanding contributions to genetics.

GRANIT, PROF. RAGNAR ARTHUR, Professor of Neurophysiology, Kungl. Karolinska Mediko-Kirurgiska Institutet, Stockholm, Sweden. Distinguished for his researches on the physiology of vision and neurophysiology.

KISTIAKOWSKY, PROF. GEORGE BOGDAN, Professor of Chemistry, Harvard University, Cambridge, Massachusetts, U.S.A. Distinguished for his work in chemical kinetics of gaseous reactions, photochemistry, thermochemistry, and structure of polyatomic molecules.

LANDAU, ACADEMICIAN LEV DAVYDOVITCH, Professor of Theoretical Physics, S.I. Vavilov Institute of Physical Problems, Moscow, U.S.S.R. Distinguished for his contributions to theoretical physics.

Exotic and Pyrophoric Fuels

Exotic spacecraft fuels may come from power-packed chemicals that ignite themselves, Dr H. A. Beatty of the Ethyl Corporation, Detroit, Michigan, indicated at the American Chemical Society's 15th Southwest Regional Meeting.

These substances offer the prospect of engines smaller and more powerful than any yet developed for aircraft, missiles, and space vehicles. High energy and pyrophoric (self-igniting) fuels, which contain boron or aluminum, can release energy more rapidly than such conventional hydrocarbon fuels as gasoline and kerosene. Hence, they produce higher heats of combustion, higher flame speeds, or both. For example, auxiliary injection of a pyrophoric alkyl aluminum fuel into a hydrocarbon-air mixture would improve combustion and thus raise power output. Also, since pyrophoric fuels ignite spontaneously on contact with air, the use of such a fuel would eliminate the need for an ignition system or, in the case of the ramjet, a flame holder.

The new fuels could be used in existing engines—such as the turbojet afterburner or ramjet—with relatively little engine modification; they would also improve the performance of these engines.

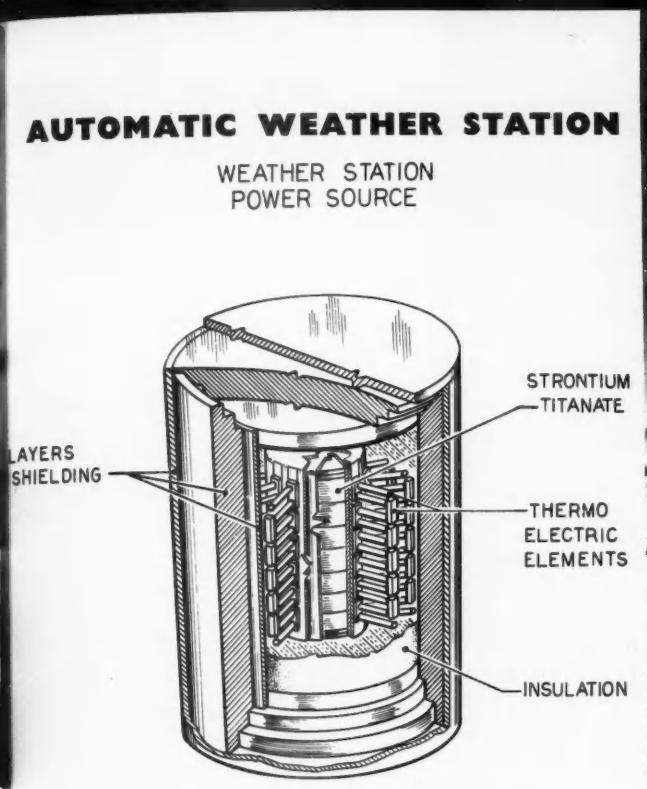
Plant Classification with a Computer

A new technique for classifying plants automatically, according to their individual characteristics, was announced at the recent meeting of the American Institute of Biological Sciences—probably the most significant development in this field since Linnaeus founded his binomial cataloguing system.

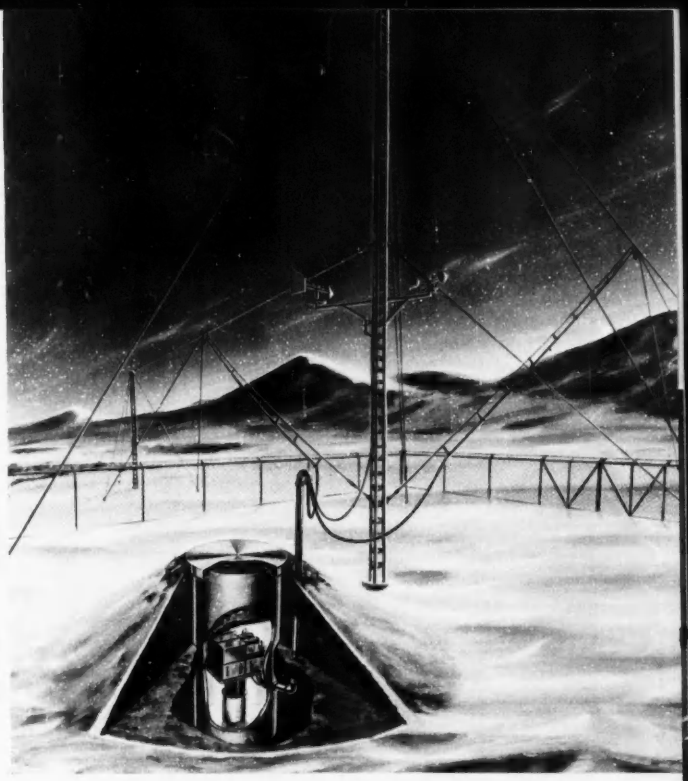
This technique uses an IBM 704 computer. Up to 100 characteristics, including size, colour, root, leaf and stem structure, are recorded on punched cards. These cards are fed into the computer, which digests this data at great speed, and automatically classifies plants into natural groups or "clusters", with each cluster being determined by the overall physical similarities of the plants that comprise it. Because the computer analyses such a great number of characteristics, it can detect subtle similarities which link plants to certain groups, and which otherwise might not be apparent even to a skilled botanist.

The first application of this new technique was to the classification of 100 varieties of *Manihot esculenta*, the tropical food plant whose roots form the basic diet of certain South American Indians. The classification arrived at by the computer could be used to find out the particular physical characteristics of this plant which are closely related to a high food yield. This, in turn, will prove useful in developing varieties with a higher yield.

AUTOMATIC WEATHER STATION



The cutaway diagram shows the arrangement of components in a 5-watt generator with no moving parts, designed by the Nuclear Division of The Martin Company in Baltimore, Maryland, and capable of powering an automatic weather station for at least two years. Strontium-90, locked safely within a stable, insoluble compound at the core of the device, would generate heat through spontaneous decay. Seventy-two thermocouples surrounding the fuel capsule would turn the heat directly into electrical energy. Although the generator is designed for land use, it could survive immersion for years in sea-water without ever releasing its radioactive fuel.



An artist's concept of a remote automatic weather station shows how the unit might be buried at an Arctic site for unmanned operation over a two-year period. The cylinder shown in cutaway form would be 8 ft. high and 32 in. in diameter. The smaller cylinder inside would contain about a pound of radioactive material, surrounded by thermoelectric elements to convert heat directly into electrical energy to be used by the weather-measuring instruments and a radio transmitter.

Science and Culture at Norwegian Hotel

The well known Mundal Tourist Hotel at Fjaerland, on Sogne Fjord, launched an interesting new experiment in conjunction with the Bergen Steamship Company and Fana Folk High School. During the summer of 1959 a group of British tourists were given practical instruction in botany and geology at Fjaerland. The agenda included excursions to Suphelle Glacier to see how the glacier is cutting a way down the valley. Before arriving at Fjaerland, the visitors spent a few days at Fana Folk High School, where they heard about Norwegian culture and Norwegian folk-songs.

New Use of Tape-Recordings

Tape-recordings have become one of the most valuable additions to the present correspondence between schools in Norway and Norwegian ships all over the world. This is due to Norsk Skipsadopsjon, an organisation which so far has arranged for the adoption of nearly 600 Norwegian vessels by approximately 1500 school children in Norway. This scheme has a dual purpose—the communications from the schools strengthen the seamen's contact with the home, and geography lessons at school become more alive for the children. Tape-recordings are especially used at the festive seasons when personal greetings from home are most welcome and appreciated by the seafaring men.

Automatic Coal Mining in U.S.S.R.

An automatic mining set eliminating the need for manual labour at the coal-face in being tested in the Donets coal basin.

Officially known as the A-2, the set is called by the miners the "machine of the future". It consists of a rapid-action knife plane, a mechanical loader, a scraper conveyor and walking hydraulic props.

Its designed capacity of 265 tons of coal an hour is equal to the average daily output of a conventional coal combine in Donbas conditions.

The machine is remote-controlled from a central panel where a single operator, by pushing buttons, puts into motion the plane which cuts off a strip of coal and signals the props to advance, pushing before them the mechanical loader and the conveyor.

Whereas in combine mining the work at the coal-face proceeds in cycles, with breaks for preliminary operations, the new machine functions practically continuously, like production lines in industry. It is estimated that only a minute will be needed to prop up the roof and to shift the loader and the conveyor along a 300-ft. coal-face.

The coal will be taken from the face to the shaft by a system of conveyors. All the auxiliary equipment (the pumping station, which contains the pressure in the hydraulic system, the magnetic station and the control panel) move with the installation.

In the experts' opinion, the A-2 set can revolutionise the mining of coal in thin seams, which account for the majority of the best coal in the Donets basin.

German Photography Prize

Recently a unique event took place in Cologne when for the first time the German Prize for outstanding achievements in Photography was given to Helmut Gernsheim of London jointly with Prof. Dr Robert Janker of Bonn. The prize, which is called in German *Kulturpreis der Photographie*, was donated by the German Photographic Society. Together with the sum of DM10,000 the recipients were each given a 7½-in. diameter plano-convex lens mounted in gold and suitably inscribed.

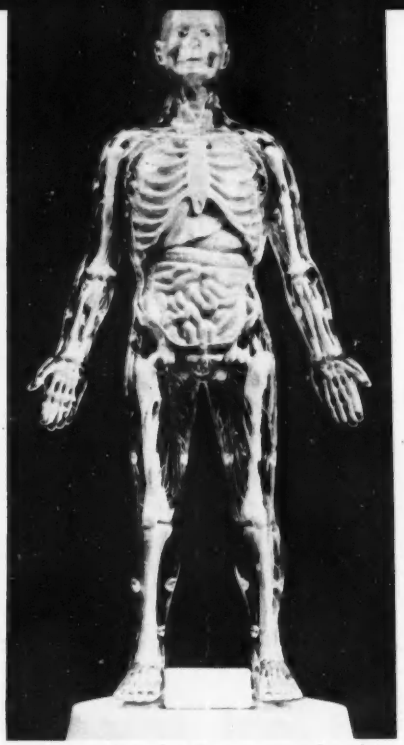
Helmut Gernsheim has been known for many years as the outstanding authority on the history of photography (see DISCOVERY, vol. 20, No. 10, p. 436). Perhaps the best known amongst his many books and publications (many of them done in collaboration with his wife, Alison) is "The History of Photography" published by the O.U.P. in 1955. The Gernsheims' personal collection of historical photographs, books, and apparatus is undoubtedly the most comprehensive one in existence outside America. Many will remember their exhibition in the Victoria and Albert Museum in 1951, entitled "100 Years of Photography". Perhaps most exciting for the Gernsheims must be their discovery of the world's first photograph taken by Nicéphore Niépce in 1826.

The other recipient of the *Kulturpreis*, Prof. Dr Robert Janker, is in his own field, as outstanding as Gernsheim. Janker's pioneer work in the field of x-ray cinematography, both the direct and the indirect method, has been admired and imitated by all who have found this technique extremely useful in diagnostic and research work. It is particularly applicable in cases of congenital heart diseases and to biological research. With the advent of the electronic image intensifier, Prof. Janker has used this new and additional technique for the even greater benefit of his patients.

The German Photographic Society is to be congratulated on having found two such outstanding recipients for its first prize —a fact which was underlined by the presentation of the prize by the German Minister of the Interior, Dr Gerhard Schröder.

The Visible Man

This is a do-it-yourself assembly kit of the human body, falling into three parts, the skin, the skeleton, and the internal organs. All the seventy-eight components are made from plastic, partly transparent and partly opaque, and the only additional items to be purchased to complete the assembly are a small tube of polystyrene



cement and polystyrene enamel paints. The completed Man stands 16 in. high and thus is approximately one-fifth life-size. The original castings are made by Renwal, Mineola, N.Y., and the kit can be purchased in England from Griffin & George Ltd, Ealing Road, Alperton, Wembley, Middlesex, for the price of 3 guineas.

This is indeed a modern version of the Victorian "Educational Toy" of which our ancestors thought so much. Its modern descendant is, however, a very great improvement, and should teach the basic elements of human anatomy to anyone prepared to spend an hour or so in its assembly. The final result is not without its own aesthetic appeal, and it is therefore strongly recommended to the young. With the kit comes a written "Introduction to Anatomy", which goes into some greater detail and provides the Latin names to a number of the bones, the muscles and the blood-vessels. It was written by Dr E. Osserman of Columbia University. The "Visible Man" is a welcome new way of teaching elementary science.

Solar Energy Research in Malta

A grant of £3115 has also been approved for a research scheme in Malta to investigate the possibilities of harnessing solar energy for water heating. The grant covers the purchase of collector, storage and distribution systems, together with ancillary items, test gear, etc., and the cost of labour and allowances for a Solar Energy Officer who, it is expected, will need to spend about a year in Malta.

New Research Vessel for Woods Hole Oceanographic Institution

An urgently needed research vessel will be provided for U.S. oceanographers by a $3 million National Science Foundation grant to the Woods Hole Oceanographic Institution, it was announced recently by Alan T. Waterman, Director of the Foundation, and Paul M. Fye, Director of the Institution.

The new vessel will replace the R/V *Atlantis*, twenty-eight-year-old "flagship" of the Institution's fleet.

U.S. oceanographers badly need adequate research vessels, and this grant is a first step in meeting the need. It results from a Foundation-sponsored series of informal conferences among both government and private oceanographers to assess the problem. Construction of a replacement for the *Atlantis* received the unanimous approval of directors of all U.S. oceanographic institutions.

A new and distinctive "research vessel type" has been evolved from these studies. It combines the best features of optimum seaworthiness and performance to be found in the "fat" trawler and "lean" Coast Guard cutter types. Preliminary design for the new vessel shows that it will make possible effective oceanographic research in the North and South Atlantic oceans, where most Woods Hole investigations are carried on. It will be able to operate under weather conditions too adverse for all but one of the present operating vessels of the institution, and should be one of the most efficient and versatile vessels afloat.

The vessel will have an overall length of 175 ft., beam of 36 ft., and loaded displacement of 1040 tons. She will have an operating range of 7500 miles at cruising speed of 12 knots. Incorporated in the design are roll and pitch damping devices, wide speed control and high degree of manoeuvrability, superior laboratory spaces, and excellent working facilities. Preliminary design plans were prepared for the Institution by M. Rosenblatt and Son of New York.

Additional design features have been considered for possible inclusion in the detailed plans and specifications, and will receive further study during design and model testing. They include anti-rolling tanks, acoustical "quietness" for studying underwater sound characteristics, a gravity laboratory, an aquarium, and ample freezer space for preserving bottom sediment cores and biological specimens.

Total complement of the ship will be thirty-seven, of whom nineteen will be scientists and the remainder officers and crew.

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